Ontology of Coherent States

Limit of Distinguishability and the Structure of Physical States

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Abstract

This work proposes an ontological framework in which physical reality is considered not as a collection of separate entities or forces, but as a coherent system of fundamental parameters and permissible transitions between states.

The concept introduces the **limit of distinguishability Δ** as a structural constraint of the system, explaining discreteness, the probabilistic nature of transitions, and the emergence of time, entropy, geometry, and fields as consequences of state coherence.

The goal of this work is to provide a **unified conceptual framework** compatible with established physical theories (General Relativity, Quantum Mechanics), allowing them to be viewed as natural consequences of the structure of reality rather than as independent postulates. This work is intended for philosophical and physical reflection, not for the direct replacement of existing theories.

Author’s note

This document represents version 1.0 and records the author’s original idea at the time of publication.

Its purpose is to create a **primary fixation of the concept** in PDF format and to ensure its accessibility and revision history through GitHub.

The author openly invites discussion and critical examination of the proposed concept, while preserving **original authorship and the fixed structural core** of the material.

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Introduction

We are accustomed to describing phenomena through a set of widely accepted but fragmented theories and formalisms: space and time, forces and fields, particles and waves. We have built civilization upon them; some provide precise calculations, others allow us to extend the boundaries of observation. Yet laws and formulas describe the world as it is, without answering the fundamental question: *why is it structured this way?*

History shows that such reflections have occurred before. Faraday, Maxwell, Einstein—each did not discard previous knowledge but instead connected it into a more coherent picture.

In this work, I propose a step of a similar nature, not toward a new physical theory, but toward ontological clarification. Gravity, electromagnetism, quantum discreteness, time—why are such diverse phenomena described in different languages, yet appear coherent in reality? This is the central question addressed by the proposed concept.

The core idea is to treat reality not as a collection of independently existing objects or fields, but as a coherent system of fundamental parameters and transitions between states within it.

Primary (fundamental) parameters are interdependent, measurable, and stable. They define not *what* exists, but *which changes are possible*.

The concept introduces the notion of a **limit of distinguishability of states**, denoted as Δ. This limit is observer-independent and represents a structural constraint of the system, determining which states are considered distinct and which are equivalent.

It is important to emphasize that this concept does not aim to replace existing physics or mathematics, nor does it introduce new forces or entities. On the contrary, it is fully compatible with General Relativity, Quantum Mechanics, and fundamental interactions. Its purpose is to offer a unified conceptual framework in which these theories appear not as a collection of separate postulates, but as natural consequences of a coherent structure of reality. In various forms, this search for conceptual coherence has been present in the works of Albert Einstein, Michael Faraday, Kurt Gödel, and others.

This work does not claim exclusive truth. It is not intended to close discussion, but rather to invite reflection and examination: does the picture of the world remain self-consistent under such an interpretation?

The following sections sequentially introduce the fundamental parameters of the system, the limit of distinguishability, and their connections to known forces and fields.

Section 1 — Ontological Foundations

1.1. State as the Basic Unit of Description

Observed reality is defined as a coherent state of a system. The system is characterized by fundamental parameters under which it can stably exist outside any temporal ordering—at this level, the concept of “time” has not yet been introduced as an independent parameter. Thus, the primary notion is not process, but the admissibility of a state.

1.2. Coherence as a Condition of Existence

If a system exists, it exists only in states that are internally coherent. Coherence is understood as the absence of contradictions between fundamental parameters—conditions under which existence does not require external compensation or lead to self-destruction.

Coherence does not imply optimality, purposefulness, or direction. It is not a principle of “the best,” but a principle of possibility.

If a set of parameters can coexist without violating fundamental constraints, such a state is admissible. Conversely, states in which parameters cannot be coherently combined (for example, those requiring infinite concentration of quantities) become inadmissible or limiting. In physics, such regimes are identified as singularities.

1.3. Fundamental and Derived Parameters

Within the framework of the concept, system parameters are divided into two orders.

First-order (fundamental) parameters:

- mass;
- energy;
- limit of state distinguishability (Δ).

They are not derived from system dynamics and do not depend on transitions. They define the very possibility of coherent states.

Second-order (derived) parameters:

- time;
- motion and velocity;

- momentum;
- fields and interactions (including gravity).

These parameters are not necessary for the existence of the system. They arise only when transitions between distinguishable states occur. In the limiting case of a completely stable and unchanging system (zero drift), such parameters may be absent.

1.4. Transition as the Elementary Act of Reality

If at least two distinguishable states of a system are admissible, a transition between them is possible. A transition is not necessarily deterministic, need not be reversible, and is not defined by intention, choice, or purpose. It follows from the fact that the system admits more than one coherent state and possesses nonzero distinguishability between them.

It is the sequence of transitions that forms:

- the experience of time,
- the direction of evolution,
- the asymmetry between past and future.

Thus, the transition is the minimal ontological act from which all dynamic properties of the system are subsequently derived.

1.5. Absence of an Observer as a Principle

A key feature of the proposed ontology is the absence of any need for an external observer. Distinguishability of states, transitions, and coherence exist independently of measurement or interpretation.

Observer, measurement, and description are special cases of system interactions, not fundamental elements of reality.

Intermediate Conclusion

At the ontological level, reality is described as a set of admissible coherent states and possible transitions between them. All familiar physical entities—space, time, fields, and forces—emerge as consequences of this structure, not as its initial components.

Section 2 — Distinguishability and the Geometry of States

2.1. Distinguishability as a Structural Constraint

In the proposed ontology, what makes two states distinct is not absolute. The system possesses a limit of distinguishability, denoted as Δ.

Δ is not a physical quantity and not a directly measurable parameter. It is not a metric magnitude, but an **ontological constraint** that *may have physical manifestations*. It defines which states the system can treat as equivalent and which as distinct. If the difference between states is smaller than Δ, they are indistinguishable for the system itself.

Thus, distinguishability is an internal property of reality.

2.2. Geometry as a Map of Permissible Transitions

If a system admits many states but not all transitions between them are possible, a structure of admissibility emerges. This structure manifests as geometry.

In ontological terms, space and geometry do not exist as independent entities. They are not fundamental and arise as descriptions of which transitions between states occur and which do not.

Geometry is therefore not a prerequisite, but a consequence of constraints on state transitions.

When constraints are homogeneous, geometry appears flat. When distributions of mass and energy modify the structure of admissible transitions, geometry becomes curved. This directly aligns with General Relativity, where spacetime curvature is determined by the distribution of mass-energy.

2.3. Gravity as an Expression of Geometric Coherence

Within the ontology of coherent states, gravity is not regarded as a force. Like geometry, it is a consequence of how mass and energy modify the structure of admissible transitions.

Objects follow the geometry permitted by coherent transitions consistent with local structure. These trajectories are interpreted as gravitational motion.

Thus, gravity is not the cause of motion, but its geometric description.

Section 3 — Time, Irreversibility, and Entropy

3.1. Time as Difference Between States

Time in this concept is not a fundamental axis or external metric. It arises only when at least two distinguishable states exist and a transition between them is possible.

If a system is fully coherent, stable, and does not transition into a distinguishable state, then time— like all second-order parameters—does not exist in the usual sense.

Time is therefore a way of ordering distinguishable transitions, not a flowing substance.

3.2. Directionality and Irreversibility

Although fundamental laws allow reversibility of transitions, asymmetry emerges at the system level. The number of admissible transition paths from state A to state B is typically much larger than the number of reverse paths.

As a result, the system statistically prefers evolution toward states with a larger number of accessible configurations. Reverse transitions are not forbidden, but their probability is exponentially small.

Thus, the direction of time arises without violating fundamental symmetry.

3.3. Entropy as a Measure of Transition Freedom

Entropy in this ontology is not the cause of system evolution. It is a measure of the number of admissible transitions between states.

High entropy corresponds to greater freedom of change; low entropy reflects rigid constraints on transitions. Entropy does not impose direction but reflects the structure of admissibility.

Geometry, gravity, time, and entropy are not independent entities. They all arise as consequences of the fundamental limit of distinguishability and the structure of permissible transitions between coherent states.

Section 4 — Quantization as a Limit of Distinguishability

4.1. Incomplete Distinguishability of States

Classical descriptions assume states can be distinguished with arbitrary precision. In the ontology of coherent states, this assumption is removed.

The limit of distinguishability Δ implies a fundamental boundary below which differences between states lose ontological meaning. This limit is not related to measurement, observers, or technical inaccuracy—it is an intrinsic property of the system. Consequently, the system may occupy a set of states that are formally distinct but ontologically equivalent.

4.2. Discreteness as a Consequence of Δ

If distinguishability is limited, transitions cannot be refined continuously. As a result, natural discreteness of admissible states and transitions emerges.

Quantization is not a fundamental “grain of reality” but a consequence of finite distinguishability. Discrete energy levels, stable states, and quantum jumps manifest this constraint.

4.3. Probabilistic Nature of Transitions

When multiple admissible transitions lie within a single distinguishability limit, the system does not select a deterministic path. A transition occurs along one of the possible paths, with probability distributions reflecting the structure of admissibility rather than the absence of causality.

Thus, the probabilistic character of quantum processes indicates not fundamental randomness, but the inability to resolve hierarchies of transitions below Δ.

4.4. Quantum Effects as Geometry of Distinguishability

Phenomena such as tunneling, interference, and superposition are described as consequences of overlapping regions of admissible states.

The system is not “simultaneously” in multiple states, but resides in a region where differences between alternative paths do not exceed Δ. Classical behavior emerges when distinguishability between paths exceeds this limit.

Section 5 — Fields and Interactions

5.1. Field as a Structure of Admissible States

In this framework, a field is not a physical substance or carrier of force. A field represents a local structure of admissible state transitions.

The presence of a field indicates that in a given region of reality, certain transitions are preferred or allowed, while others are suppressed or forbidden.

5.2. Gravitational Field

The gravitational field arises as a consequence of changes in the geometry of admissible transitions influenced by mass-energy distribution. It does not act on objects but describes the structure of paths along which coherent transitions may occur.

In this sense, the gravitational field coincides conceptually with the geometric interpretation of General Relativity.

5.3. Electromagnetic Field

The electromagnetic field is interpreted as a structure of admissible transitions associated with distributions of charges and currents. Changes in charge states create regions of admissible transitions for other charges.

Unlike gravity, electromagnetic interaction allows both attractive and repulsive structures of admissibility, reflecting the distinction of charge signs.

5.4. Strong and Weak Interactions

Strong and weak interactions are viewed as highly localized structures of admissible transitions manifesting at microscopic scales.

Their specificity arises not from fundamentally different laws, but from different regimes of coherence and distinguishability.

Final Conclusion

Quantization, fields, and fundamental interactions do not require the introduction of new ontological entities. All arise as different manifestations of the limit of distinguishability and the structure of admissible transitions between coherent states.

Conclusion

This work proposes an ontological framework in which physical reality is treated not as a set of independent entities or forces, but as a coherent system of admissible states and transitions between them.

At the foundation lies the assumption that a system exists only insofar as its fundamental parameters are coherent. Mass, energy, field structure, and state distinguishability are not introduced as derived quantities, but as primary elements that do not exist independently. The system does not pursue goals or possess intention—its stability is ensured by parameter coherence itself.

Time is not introduced as an external axis or universal flow. It is defined as the difference between system states arising exclusively during transitions. In limiting cases where transitions are absent, time loses its meaning as a physical quantity, remaining only an abstract descriptive parameter.

Gravity is interpreted not as a force, but as the geometry of admissible state transitions arising from mass-energy distribution. Object trajectories are formed not by “attraction,” but by coherence constraints under which admissible transitions organize into stable patterns perceived as spacetime curvature.

Quantization is introduced as a fundamental limit of state distinguishability (Δ), rather than as a property of particles, waves, or measurement acts. Incomplete distinguishability naturally leads to:

- discreteness of states;
- probabilistic transition behavior;
- the impossibility of complete determinism at microscopic scales.

Uncertainty is not ontological “randomness,” but reflects the limits of information available to the system itself.

Entropy is interpreted as a measure of the availability and number of admissible transitions, not as a prohibition or external law. Irreversibility arises statistically: reverse transitions are in principle possible, but require highly specific state sequences whose probability is exponentially small. Thus, the arrow of time and entropy growth emerge from the structure of admissible transition space, not from fundamental asymmetry of laws.