

Criteria of Physical Reality Based on Causally Completed Acts of Fundamental Interaction

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19th November 2025

Problem Statement

Modern physics lacks a coherent and operationally grounded criterion for what should be regarded as physically real. Classical ontology assumes the independent existence of objects and fields, while quantum theory reduces physical processes to probabilistic amplitudes without specifying the conditions under which an entity attains reality. Relativistic frameworks treat time as an external parameter, not as a property emerging from fundamental interactions. As a result, existing theories do not provide a clear definition of when a physical entity acquires ontological status, how duration arises, or what distinguishes realized physical processes from merely hypothetical or mathematically definable constructs. This conceptual gap motivates the need for a criterion of physical reality based on causally completed fundamental interaction events.

Core Thesis

A physical entity attains ontological status only upon the realization of a causally completed act of fundamental interaction. Anything that has not realized such an interaction does not possess ontological status and cannot give rise to duration. Only what realizes a causally completed act of fundamental interaction and leaves a physically detectable causal trace can be regarded as real.

Implications

The proposed criterion redefines physical reality in explicitly interaction-based terms. If an entity acquires ontological status only through causally completed acts of fundamental interaction, several conceptual consequences follow for the interpretation of time, space, matter, consciousness, and vacuum effects in contemporary physics.

First, objects and fields cannot be considered ontologically independent entities. Their physical reality is reduced to networks of realized interactions that generate detectable causal traces. In the absence of such interactions, neither objects nor fields possess ontological grounding.

Second, duration becomes a measurable consequence of completed interaction events rather than an externally imposed temporal parameter. Physical time emerges as the integration of such durations and has no physical meaning in interaction-free regimes. Thus, time lacks autonomous ontology and is operationally reconstructed from the causal structure of realized events.

Third, space does not constitute an independent physical substance. Spatial relations, metric properties, and geometric structures arise as emergent features of the causal network generated by completed interactions. Without events, there are no distances, extensions, or geometric attributes. Space is therefore understood as the morphology of the interaction network rather than as a fundamental entity.

Fourth, mass is not a substance but a real physical effect produced through completed interactions, including gravitational coupling, the Higgs mechanism, and internal interactions within composite particles. Its ontological status is determined exclusively by the measurable causal consequences it generates.

Fifth, consciousness attains ontological reality insofar as it corresponds to sequences of electromagnetic interaction events within neural structures, which produce stable causal traces such as synaptic modifications and functional changes in neural networks. It does not exist independently of the physical interactions that constitute it.

Sixth, vacuum fluctuations are not ontologically real as standalone entities. Their reality is manifested only through measurable effects—such as the Casimir force, the Lamb shift, or vacuum polarization—which correspond to completed interactions. Prior to such interactions, vacuum fluctuations remain non-ontological potentialities.

Seventh, measurement should be regarded as a particular case of interaction rather than a metaphysical act of observation. Only those aspects of a system that generate a causal trace through interaction achieve ontological status. Hypothetical constructs—including unobserved field configurations, unrealized quantum branches, and counterfactual trajectories—lack physical reality in the absence of completed interactions.

Taken together, these implications provide a unified ontological framework in which physical existence, temporal structure, spatial morphology, and material properties are grounded exclusively in causally completed fundamental interactions. This approach avoids reliance on external temporal parameters, absolute spatial backgrounds, or metaphysical assumptions, offering a coherent and operationally defined foundation for physical ontology.

Conclusion

A coherent and conceptually grounded criterion of physical reality can be formulated by identifying the causal completeness of fundamental interaction as the necessary and sufficient condition for ontological status. Only entities that realize such interactions—and leave detectable causal traces—can be regarded as real. Everything else lacks ontological grounding and cannot give rise to duration or physical time.

By shifting the focus from objects and states to completed elementary interactions, this approach provides a consistent and non-metaphysical foundation for understanding physical existence, temporal structure, and causality. It unifies quantum events, measurable physical effects, and causal relations into a single conceptual framework, thereby addressing long-standing gaps in prevailing physical ontologies