

Abstract: *CAUSALITY*

We raise questions of causation for the origins of spacetime. How does emergence from an entangled initial state explain a classical universe described by Einstein gravity? How will gravity modify the standard cosmological model? How can string theory as quantum theory with classical origins describe temporal change?

Our purpose is coherence in initial-state physics of a new paradigm describing unobservable causal phenomena prior to CMB evidence of physical reality. We construct a narrative bridging philosophy and the physics of mechanisms at initial and possible preceding states of confirmed observables such as gravitational waves.

Wittgenstein's positivist fallacy that physical facts are all the facts contradicts the physics of quantum entanglement and acausal time evolution with complex dynamical information emerging from a classical origin inaccessible to the senses. We investigate the limits of the senses in assessing nonphysical facts in order to formalize standards of verification that separate physics from the metaphysics of events without observational means to refute theory.

Sense-data verification of dynamics from the Planck scale to the expanding phase requires consensus on criteria for physical theory to be falsifiable. Ontological coherence presupposes a formal separation of observables from unobservables, as Newton first noted on the difference between physics and metaphysics (*Principia*: 3rd edition, 1726) in which he refrains from assigning unobservable cause to gravity, a trope Hume would formalize on the distinction of factual from evaluative reasoning. Our paradigm reinterprets the metaphysics of Descartes and Leibniz known by Newton, Hume, and Einstein.

The standard cosmological model mirrors indeterminate aspects of Enlightenment physics and philosophy of causation. Factual evidence for any initial state remains conjectural. Analysis of early classical and quantum gravity is unverified. Mechanisms describing acceleration of cosmic expansion are unknown. Gravitational effects of the dark sector on structure formation are unobserved. The ontological status of the wave function is uncertain. Physics of black-hole interiors and string dualities is incomplete.

Coherent empirical theory of indeterminate phenomena predicts unbiased results that demonstrate consistent mathematical logic, uphold existing proven theory, and confirm experimental observation where theory is incomplete. We argue that observables are necessary but insufficient to foundational criteria for verification or falsification of theory. Where observables elude the community we infer probabilities in cases such as emergence of gravity from quantum fields. Our paradigm of early-universe causation formalizes a coherent method of analysis for physical and metaphysical facts hidden between the lines of the book of nature.

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