

Executive Summary

The Change of the Metric Signature and the Birth of the Universe

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The Wick rotation, a method employed in standard quantum field theory to regularize a route integral, gave rise to the notion of quantum transitions from a physical continuum with the Euclidean signature to a Lorentzian spacetime. The path integral over field configurations can thus be defined in either Minkowski spacetime or Euclidean space, with one of the coordinates in the latter being the so-called "imaginary" time because of the transformation. Even if one assumes a transition that led to the birth of the universe, the idea of these transitions is still purely speculative because they must occur outside of time, negating the idea of causation.

Although the Sakharov work has not been cited by the authors of the current paper, it appears that the notion of a physical continuum made up of regions with various signatures is more in line with Sakharov's theories than with the "no boundary" concept. The writers of this essay examine the hypothesis that the universe originated at a place on an ill-defined physical continuum where time does not exist. This concept implies the idea of a signature change, which occurs when one of the metric tensor's main values changes its sign. More particular, it is hypothesized that the metric tensor's g_{00} component's sign changes.

The developer of quantum geometrodynamics, underlined that only three-geometry makes sense. The wave function estimates the likelihood that the universe contains some three-geometry, independent of the four-geometry in which it is embedded, and which is determined by the lapse and shift function values. The lapse and shift functions, which provide a reference frame, are said to have no bearing on the wave function of the universe. In contrast, any solution to the Einstein equations can only be found in general relativity, the theory we are attempting to quantize.

It can be characterized as a spontaneous violation of the characteristic symmetry, which has lately been studied in the literature. The physical characteristics of space have now undergone a significant restructuring. A change from a space with the Euclidean signature, where no physical effects may spread, to a spacetime with its causal structure, which allows for physical interactions, including electromagnetic ones, is being made.

Source: [Physics](#)

KEYWORDS

Path integral quantization; metric signature; wave function of the Universe

