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Title: Non-smooth spacetimes and Lorentzian length spaces

Abstract:
Spacetimes arising in general relativity often exhibit non-smooth features that challenge traditional differential geometric approaches to Lorentzian geometry. Following the successful development of synthetic Riemannian geometry—where triangle comparison and optimal transport methods have extended curvature concepts beyond smooth manifolds—recent work has established the foundations for an analogous synthetic Lorentzian geometry based on the fundamental notion of Lorentzian length spaces. These spaces capture the essential causal structure of spacetime without requiring smoothness or a manifold structure at all. In this talk we explain the basics of this new geometry, outline initial results including comparison theorems and convergence results, and explore potential applications in general relativity and discrete approaches to quantum gravity.