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Synthetic (metric) methods in General Relativity and Lorentzian geometry - Part 1: Lorentzian length spaces

I will review some recent progress on developing causality theory and curvature bounds for Lorentzian length spaces. This is a synthetic
approach which does not need a smooth or manifold structure. Its main application is to spacetimes of low regularity and in spirit it is akin to the theory of Alexandrov and CAT(k)-spaces in metric geometry. A main focus of this work is the introduction of synthetic curvature bounds based on triangle comparison with model spaces of constant curvature.

Synthetic (metric) methods in General Relativity and Lorentzian geometry - Part 2: Applications

Examples of Lorentzian length spaces include Lorentzian manifolds with metrics of low regularity, closed cone structures, and warped products of a line with a (Riemannian) length space, so called generalized cones. The theory can be applied to study the low regularity (in)-extendibility of spacetimes and it can be shown that inextendibility is related to a (synthetic) curvature blow-up. We will briefly review these applications and then focus on very recent work with Robert McCann (https://arxiv.org/abs/2110.04386), where we define a family of canonical measures on Lorentzian
length spaces, which in turn, allows one to define a synthetic dimension akin to the Hausdorff dimension of metric spaces. Applications to continuous spacetimes and connections to curvature bounds are given.