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FAKULTÄT FÜR MATHEMATIK
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Einladung zur öffentlichen Defensio von

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Thema der Dissertation:

Geodesic completeness and global hyperbolicity for non-smooth spacetimes

Abstract:
General relativity as a geometric theory has been developed for smooth Lorentzian metrics and therefore extending notions and methods to non-smooth settings is a mathematically challenging endeavor. Nonetheless, physically relevant models of spacetimes (shock waves, matched spacetimes, conical singularities, impulsive waves, etc.) and the initial value formulation of general relativity demand this extension to settings of low regularity.

In this thesis we extend two geometric notions, whose purpose is to exclude genuine singularities, to non-smooth settings. In fact, we are interested in regularity classes below $\mathcal{C}$ (the first derivative of the metric exists and is Lipschitz continuous), which is the most general class where the bulk of classical Lorentzian geometry remains valid.
The first of these conditions is geodesic completeness. We prove a completeness result for so-called impulsive N-fronted waves with parallel rays (NPWs), which are generalizations of impulsive pp-waves and give a precise definition of geodesic completeness in the framework of the geometric theory of generalized functions. We conclude our treatment of geodesic completeness by investigating geodesics in non-expanding impulsive gravitational waves propagating in spaces of constant curvature.
One purpose of the second condition — global hyperbolicity — is to exclude so-called "naked singularities". We study the globally hyperbolic metric splitting for a class of non-smooth NPWs. Furthermore we extend the usual notion of global hyperbolicity (based on the compactness of the causal diamonds) to spacetimes with continuous metrics and show that several classically valid equivalences and implications still hold.

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