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FAKULTÄT FÜR MATHEMATIK
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Einladung zur öffentlichen Defensio von

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Thema der Dissertation:

Singularity theorems and rigidity in Lorentzian geometry

Abstract:
The classical singularity theorems of General Relativity show that a Lorentzian manifold with a C^2-metric that satisfies physically reasonable conditions cannot be causal geodesically complete. One of the questions left unanswered by the classical singularity theorems is whether one could extend such a spacetime with a lower regularity Lorentzian metric such that the extension still satisfies these physically reasonable conditions and does no longer contain any incomplete causal geodesics. The natural differentiability class to consider here is $C^{1,1}$: This regularity corresponds, via the field equations, to a finite jump in the matter variables, a situation that is not a priori regarded as singular from the viewpoint of physics and it is the minimal condition that ensures unique solvability of the geodesic equations. Recent progress in low-regularity Lorentzian geometry has allowed us to tackle this question and show that, in fact, even one of the most general classical singularity theorems, the Hawking-Penrose theorem, remains valid for $C^{1,1}$-metrics. Mathematically these theorems rely on using curvature bounds (in particular lower bounds on the causal Ricci curvature) to gain estimates on the occurrence of conjugate points and thus bear many similarities to comparison results from Riemannian geometry. Conversely, some Riemannian results have Lorentzian counterparts. We will start by discussing a recent (spacetime) volume comparison result of Treude and Grant and its generalization to $C^{1,1}$-metrics. Further, we shall briefly touch upon the rigidity arising from assuming maximality of certain quantities in this setting for smooth metrics. After this I am going to try and explain some of the challenges we faced in proving the Hawking-Penrose theorem for $C^{1,1}$-metrics, in particular compared to earlier singularity theorems generalized to the $C^{1,1}$ case. Finally, we briefly turn to the related issue of (in-)extendibility questions in general and state a Lipschitz inextendibility result for (smooth) timelike geodesically complete spacetimes.

Prüfungssenat:

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