UNDERGRADUATE SUMMER RESEARCH

SVEN HIRSCH

Project title: Mathematics of gravitational waves and black holes

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Project description: Black holes and gravitational waves are among the most striking predictions of General Relativity. Gravitational waves, for instance, were predicted theoretically shortly after Einstein introduced the theory, yet they were confirmed experimentally only about a decade ago. Despite this remarkable progress, many aspects of their underlying mathematical structure remain poorly understood.

From a geometric perspective, both gravitational waves and black holes can be modeled as Lorentzian manifolds satisfying specific geometric conditions, such as curvature bounds. This project focuses on the interplay between scalar curvature—encoding the energy density of spacetime—and mean curvature, which plays a central role in the mathematical description of black hole horizons, with applications to both black holes and gravitational waves.

A detailed project description will be provided after successful admission to the program.

Project goal: By the end of the summer, participants are expected to obtain new mathematical results leading to a research paper.

Prerequisites: An excellent background in differential geometry is required. Some familiarity with spin geometry, partial differential equations, and General Relativity is helpful but not mandatory.

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