Sommersemester 2023

Null Geometry in General Relativity

Lecturer: Markus Wolff
Start: **Friday, April 21**
Time: **Friday, 8:15–10:00, C9A03 (lecture has been moved!)**
Platform: please join the ILIAS group Null Geometry 2023, all information will be shared there
Modul number: MAT-60-08, 5 ECTS

Description

Most information from far-away stars and galaxies reaches us as signals travelling at the speed of light. Null Geometry provides a framework in the context of General Relativity to study the properties of lightrays from a mathematical perspective.

We will benign with a brief introduction to Lorentzian Geometry. In particular, we introduce the Minkowski spacetime and its isometry group as a first model to look at null geodesics and the standard lightcone before discussing these objects in a larger class of spacetimes. A significant part of the course will be dedicated to the study of submanifolds in an ambient spacetime and we will also discuss the case of higher codimension. More specifically, we will study the extrinsic curvature of null hypersurfaces and spacelike codimension-2 surfaces sitting inside these null hypersurfaces. In the end, we will apply the developed theory to the example of the standard Minkowski lightcone studied in the beginning, and establish a relation between surfaces on the lightcone and the conformal geometry of the 2-sphere.

This course can but need not be attended in combination with the Mathematical Relativity course offered by Prof. Carla Cederbaum.

Requirements

Geometry in Physics or Differential Geometry

Useful, but not required: Linear PDEs

Literature

R. M. WALD, *General Relativity*, The University of Chicago Press (1984)

B. O'NEILL, *Semi-Riemannian Geometry With Applications to Relativity*, Academic Press, Math. 103

J. SAUTER, *Foliations of Null hypersurfaces and the Penrose Inequality*, Dissertation (ETH Zürich), url: `https://www.research-collection.ethz.ch/handle/20.500.11850/150826`

Office hour

There will be a weekly office hour Wednesdays from 16:00 to 18:00 in my office (C6P31).

Excercise class and Exam

There will be an exercise class once every two weeks. The time will be decided in the first lecture.
Most likely there will be an oral exam.

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