EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

Mathematisch-
Naturwissenschaftliche
Fakultät
Fachbereich Mathematik
AB Geometrische Analysis,
Differentialgeometrie und
Relativitätstheorie

Summer term 2019

Mathematical Relativity

Lecturer: Dr. Melanie Graf
Time and place: Tue and Thu, 4.15 pm to 6 pm, **N16**; starting Apr 16

Teaching assistant: Sophia Jahns, jahns@math.uni-tuebingen.de

Description

After a short introduction to Special Relativity and its underlying Minkowskian geometry, we will study general Lorentzian manifolds and the Einstein equations of General Relativity.

One part of the lecture course will focus on static solutions of the Einstein equation, describing spacetimes that are in a state of equilibrium. These solutions are geometrically rather simple and therefore suitable for a first approach to geometric, analytic, and physical questions about spacetimes and isolated systems. In particular, we will prove the Bunting–Masood-ul-Alaam static black hole uniqueness theorem.

In the second part, we will investigate causality, cosmological models, and the Big Bang, specifically the Penrose–Hawking singularity theorems.

Requirements

Geometry in Physics **or** Differential Geometry **or** Mathematische Physik: Klassische Mechanik

Useful, but not required: Linear PDEs

Literature

R. M. Wald, *General Relativity*, The University of Chicago Press (1984)
H. Fischer und H. Kaul, *Mathematik für Physiker, Band 3*, Springer Spektrum, 3. Auflage (2013)
B. O'Neill, *Semi-Riemannian Geometry With Applications to Relativity*, Academic Press, Math. 103
S. W. Hawking und G. F. R. Ellis, *The large scale structure of space-time*, Cambridge Monographs on Mathematical Physics (1973)

Exam

To be admitted to the exam, you will need to get 50% of all points on the exercise sheets (including the project theses, see below). Depending on the number of participants, the exam will be written or oral.

Project theses

In the week of June 24 to 28, the participants will be asked to write little project theses about classicals result in GR instead of solving exercises. The project theses will count like two exercise sheets.

Exercise classes

Time and place to be determined in the first lecture.