

Hauptseminar Analysis

General Relativity

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This seminar provides an introduction into General Relativity and related aspects of Analysis. In addition to central aspects of Lorentz geometry we discuss globally hyperbolic space-times, the Cauchy problem, Schwarzschild and Kerr solutions to the Einstein equations, black holes, as well as relations to elliptic PDE on hyperbolic spaces. Basic knowledge of differential and Riemannian geometry is a prerequisite for participation. The seminar will be held in english.

1. **Review of Riemannian geometry.** [2] §A.3 und §A.4
2. **Time orientation.** [5] §2.1 and §2.2
3. **Causal curves on space-times.** [5] §2.4-2.6; [2] §2 p. 18-22
4. **Global hyperbolicity.** [5] §2.7-2.8, [2] §2 p. 23-24
5. **Cauchy surfaces and the Cauchy problem.** [5] §2.9-2.12
6. **Cauchy problem for the Einstein equation.** [4], §1.1-1.3
7. **The constraint equations for the Einstein equation.** [4] §3.1
8. **Schwarzschild solution and black holes.** [1] §7 p. 165-205
9. **Reissner-Nordstrom and Kerr solutions.** [1] §7 p. 206-216
10. **Strong cosmic censorship conjecture.** [4] §2.1-2.4
11. **Stability of Minkowski space time.** [4] §2.6, §2.6.3
12. **High energy resolvent estimates on hyperbolic mfd's.** [6]

13. Mass of a space-time and positive mass theorem.**Literature:**

- [1] Carroll, *Lecture Notes on General Relativity*
- [2] Bär, Ginoux, Pfäffle, *Wave Equations on Lorentzian Manifolds*
- [3] Müller, Sanchez, *An Invitation to Lorentzian Geometry*
- [4] Chrusciel, *Cauchy problems for the Einstein equations*
- [5] Chrusciel, *Elements of causality theory*
- [6] Vasy, *Microlocal analysis of asymptotically hyperbolic [...] spaces*