SEMINAR LORENTZIAN GEOMETRY, SUMMER TERM 2019

JUN. PROF. DR. KLAUS KRÖNCKE

Time/Place: Monday, 6-7:30 pm, GEOM 241. Note that there is no seminar on April 1 and June 3!

Lorentzian geometry forms the framework for the mathematical modelling of curved spacetimes and has important applications in theoretical physics, in particular in general relativity. We will study foundations in Lorentzian geometry as well as appilcations in general relativity. Our main source is [2]. Further relevant books are [3, 4, 5]. For the seminar, basic knowledge in differential and Riemannian geometry ((pseudo-)Riemannian metrics, covariant derivative, geodesics, curvature) is preassumed.
The lengh of the talks are 90 minutes. Plese include a few minutes of discussion in your schedule. Furthermore, you should also submit a script of your talk one week before you give it.
For the preperation of your talk, I recommend to read the text "'Wie halte ich einen Seminarvortrag"' (in German) of Prof. Dr. Manfred Lehn:
`http://www.math.uni-konstanz.de/numerik/personen/gubisch/de/teaching/ss15/Lehn-Seminarvortrag.pdf`
The contents of the first talks are as follows (Unless otherwise stated, chapter and page numbers refer to [2]):

- **Talk 1 on April 8: Galileo and Minkowski Spacetime**
  (Fabian Bleitner) Chapter 6.1 and 6.2 (p. 252-264).
- **Talk 2 on April 15: Cartan Structure Equations**
  (Neetish Pradhan) Chapter 4.2 (p. 132-141).
- **Talk 3 on April 29: Cartan Connections, Foundations of Lorentzian Geometry and the Einstein Equation** (Felix Rieth)
  Chapter 6.3 und 6.4 incl. exercises 2 und 8 of 6.4 (p. 265-272).
- **Talk 4 on May 6: The Schwarzschild Solution**
  (Jan Hottenrott) Chapter 6.5 incl. exercise 6 (p. 272-284).
- **Talk 5 on May 13: Robertson Walker Spacetimes**
  (Jonte Gödicke) Chapter 6.6 incl. exercises 4 und 7 (p. 284-290).
- **Talk 6 on May 20: Causality** (Xinyang Liu) Chapter 6.7
  (without the proof of Proposition 7.1) incl. exercises 6 und 7 (p. 290-298).
- **Talk 7+8 on May 27 and June 17: Hawking Singularity Theorem**
  (Samanyu Sanjay, Miroslava Mosso Rojas) Chapter 6.8 (p. 298-311).
- **Talk 9 on June 24: Penrose Singularity Theorem**
  (Lidiya Pryymak) Chapter 6.9 (p. 311-318).
- **Talk 10 on July 1: Global Hyperbolicity**
  (Julian Farnsteiner) [1, Section 2.10]
- **Talk 11 on July 8: Wave equations on Lorentzian manifolds**
  (Klaus Kröncke)

References

[1] C. Bär, *Lorentzgeometrie*, Vorlesungsskriptum, 2004.
https://www.math.uni-potsdam.de/fileadmin/user_upload/Prof-Geometrie/Dokumente/Lehre/Lehrmaterialien/skript-LorGeo.pdf.

[2] L. Godinho and J. Natário, *An introduction to Riemannian Geometry. With Applications to Mechanics and Relativity*, Springer Universitext, 2014.
https://www.springer.com/de/book/9783319086651.

[3] S. W. Hawking and G. F. R. Ellis *The large scale structure of space-time*, Cambrige University Press, 1973

[4] B. O'Neill, *Semi-Riemannian Geometry. With Applications to Relativity*, Academic Press, 1983.

[5] R. M. Wald, *General Relativity*, University Chicago Press, 2010