Wintersemester 2018/19

Geometry of Initial Data Sets

Instructor: Dr. Armando Cabrera Pacheco
Start: Wednesday, October 17th
Time and place: Wednesday, 12 c. t. to 14, in C-Building Room 9A03
Monday, 16 c. t. to 18, in C-Building Room S11 (problem session)

Description

The main goal of this course is to gain a working understanding of some classic and current research topics in mathematical relativity.

We will be mainly interested in studying the geometry of initial data sets for the Einstein Equations, i.e., spacelike slices of spacetimes satisfying certain physical assumptions. Mathematically, they correspond to Riemannian manifolds with geometric constraints.

The course will start with a careful review the geometric constraints to be imposed on an initial data set and the concept of total mass. Then we will study the main ideas behind the proofs of the positive mass theorem and the Riemannian Penrose inequality. After this, some selected topics about graphical initial data sets, quasi-local mass notions, and explicit initial data set construction will be covered.

Requirements

Geometry in Physics and Mathematical Relativity or some other course containing some submanifolds theory.

Literature

CABRERA PACHECO, A. J., CEDERBAUM, C., MCCORMICK, S., AND MIAO, P., *Asymptotically flat extensions of CMC Bartnik data*, Class. Quantum Grav. **34**, 2017.

HUISKEN, G. AND ILMANEN, T., *The inverse mean curvature flow and the Riemannian Penrose inequality*, J. Differential Geom. **59**, 2001.

LAM, M.-K. G., *The graphs cases of the Riemannian positive mass and Penrose inequalities in all dimensions*, arXiv:1010.4256, 2010.

LEE, J. M., *Riemannian manifolds: An introduction to curvature*, Graduate Texts in Mathematics **176**, Springer-Verlag New York, 1997.

MANTOULIDIS, C., AND SCHOEN, R., *On the Bartnik mass of outer apparent horizons*, Class. Quantum Grav. **20**, 2015.

SCHOEN, R., YAU, S.-T., *On the proof of the positive mass conjecture in general relativity*, Comm. Math. Phys. **65**, 1979.

* This is not an extensive list. We will only cover parts of these references and they are not intended to be covered prior to the class.

Exam

Each student will be asked to explain solutions to relevant homework exercises during the exercise sessions (these will be timely assigned). To be admitted to the exam (written or oral depending on the size of the class), you will need to have presented at least three exercises at a satisfactory level.