



Sommersemester 2017

## Introduction to Numerical Relativity

**Dozent:** Dr. Leon Escobar

**Beginn:** Freitag, 21. April 2017

**Zeit:** Freitag, 10 Uhr c. t. bis 12 Uhr, N14

**ECTS Punkte:** 3

**Prüfungsgebiet:** Angewandte Mathematik

### Beschreibung

The cornerstone of the general relativity theory is the Einstein's field equation which describes the gravitational field as result of the interaction between the curvature of the space-time and its energy content. In general, this equation consists of ten coupled non-linear partial differential equations which are, with exception of some few cases, hard to be solved simultaneously. The numerical relativity emerges as a response for dealing with such complexity by introducing analytical and numerical techniques that makes possible solving the equations in a large variety of situations. The purpose of this lecture is to provide a basic introduction to this subject. In the first part, the geometric  $3 + 1$ -decomposition of the space-time will be introduced as well as the most used approaches for solving the resulting equations. In the second part, it will be presented the standard approaches for the construction of initial data and the choice of suitable coordinates. The course finishes by discussing, in the  $3 + 1$ -decomposition context, the equations that model the most common energy sources, namely; dust, a perfect gas, scalar and electromagnetic fields.

### Voraussetzungen

One lecture in differential geometry and numerical methods as well as a very basic knowledge of some programming language.

### Literatur

M. ALCUBIERRE, *Introduction to  $3 + 1$  Numerical Relativity*, Oxford Science Publications (2008)

T. W. BAUMGARTE AND S. L. SHAPIRO, *Numerical Relativity: Solving Einstein's Equations on the Computer*, Cambridge University Press (2010)

E. GOURGOULHON,  *$3+1$  Formalism in General Relativity: Bases of Numerical Relativity, volume 846*, Springer Science and Business Media (2012)

### Prüfung

There will be an individual assignment which will be worth half of the final mark. The other half will be determined by an oral exam.