



Universidade do Minho



MAP-fis Essay Proposal, 2015-2016

Supervisor

Name: Filipe Mena

e-mail: fmena@math.uminho.pt

Title

Exact models of gravitational collapse to black holes with gravitational wave emission

Area

General Relativity

Summary of Proposal

The recent detection of gravitational waves by LIGO has brought extra motivation to investigate models of gravitational collapse emitting gravitational waves. This can be done using two different approaches: either using perturbative methods or exact solutions of the Einstein Field Equations. In this essay, the idea is to concentrate on the later approach.

As is well known, due to Birkhoff's theorem, it is not possible to have gravitational radiation on spherically symmetric exact vacuum spacetimes. The next simplest symmetry assumption is cylindrical symmetry. In this context, the exact solution found by Einstein and Rosen [3] is of importance. In the first part of the essay, the idea is to review the mathematical and physical properties of the Einstein-Rosen solution as well as the physical models (of collapse, in particular) where it has played a role in the emission of gravitational waves.

Secondly, other families of gravitational wave exact solutions would be revised, such as pp-waves, including soliton solutions [1] and plane waves [2] when they can (potentially) act as exterior spacetimes to some collapsing interior configuration (e.g. a dying star).

The final goal is to write a state-of-the-art essay about models of gravitational collapse to black holes with gravitational wave emission, which use exact (not approximate) solutions of the Einstein Field equations.

References

- [1]. V. Belinski, E. Verdaguer, "Gravitational solitons", Cambridge Univ. Press, 2001.
- [2]. H. Stephani et al., "Exact solutions of Einstein's field equations", Cambridge Univ. Press, 2003
- [3]. A. Einstein, N. Rosen. "On Gravitational waves", *J.Franklin Inst.* 223:43-54, 1937