

School of Mathematical Sciences

PhD Studentships

Project title:

Non-linear perturbations of cosmological models and black hole spacetimes

Project area:

Mathematical General Relativity

Supervisor(s):

Dr. Juan Antonio Valiente Kroon
Reader in Applied Mathematics
j.a.valiente-kroon@qmul.ac.uk
www.maths.qmul.ac.uk/~jav

Start date:

October 2012

Project details:

One of the outstanding challenges in General Relativity —the relativistic theory of gravity—is to gain analytic control of the solutions to the Einstein field equations in the large: physical questions in General Relativity require knowledge of the non-linear behaviour and properties of solutions to non-linear partial differential equations. Such undertaking is, very often, only feasible in the case where the solutions under consideration are suitably close —that is, a perturbation— to an (usually) explicitly known background solution. The standard approach to this problem has been the study the evolution and properties of linearised perturbations. This approach, however, offers a limited understanding of non-linear mechanisms. The objective of the present project is to analyse fully non-linear evolution problems in a range of settings in General Relativity ranging from Cosmology to the theory of black holes. The insights gained from the study of non-linear perturbations is key to understand the physical content of General Relativity as the background solution are often attractors of the theory.

The approach to these problems will be based on a number of techniques of conformal geometry and the theory of partial differential equations recently developed by the supervisor —see the bibliography enclosed. The project will be mainly analytical, but it will involve certain amount of computer algebra and simple numerical simulations.

References:

C Lübbe & JA Valiente Kroon. *On de Sitter-like and Minkowski-like spacetimes*. Class. Quantum Grav. **26**, 145012 1 to 26 (2009). **Named research highlight by the editorial board of the journal.**

C Lübbe & JA Valiente Kroon. *A stability result for purely radiative spacetimes*. J. Hyp. Diff. Eqns. **7**, 545-579 (2010).

C Lübbe & JA Valiente Kroon. *The extended Conformal Einstein field equations with matter: the Einstein-Maxwell field*. Available at arXiv1102.2399[gr-qc].

C Lübbe & JA Valiente Kroon. *A conformal approach for the analysis of the non-linear stability of pure radiation cosmologies*. Available at arXiv:1111.4691[gr-qc].

Suitable candidates:

The successful candidate should have good background in General Relativity, including black holes (the Schwarzschild and Kerr exact solutions) and Cosmological models (Friedman models). Knowledge of Differential Geometry going beyond what is needed for a first course on General Relativity is also desirable. Familiarity the computer algebra system Mathematica and readiness to combine analytic and numerical approaches will constitute beneficial assets.

Funding details:

The studentship is funded by a DTA from the EPSRC and will cover student fees and a tax-free stipend starting at £15,590 per annum and is available to candidates of all nationalities.

Information about the School of Mathematical Sciences:

The School of Mathematical Sciences is one of the largest UK mathematical science departments and is one of five Schools in the Faculty of Science and Engineering at Queen Mary. The School offers energetic and diverse postgraduate activity across the spectrum of mathematical sciences from pure and applied mathematics to statistics. Our staff includes international leaders in many areas of mathematical research, and the School is a hive of activity, providing a vibrant postgraduate life. For more information about the School please see <http://www.maths.qmul.ac.uk/>

Contact:

Informal enquiries can be made by email to Dr. Juan A. Valiente Kroon, j.a.valiente-kroon@qmul.ac.uk.

How to apply:

To apply for this studentship and for entry on to the mathematics research programme please fill in online application form at <http://www.qmul.ac.uk/postgraduate/applyresearchdegrees/index.html>

If you have any queries regarding the application process please contact the postgraduate administrative officer (maths-pg@qmul.ac.uk / +44 (0)20 7882 5454).

Application deadline:

Deadline for applications is 31st January 2012.