LTCC Advanced Course

Title: Numerical Relativity

Basic Details:

- Core Audience – all are welcome subject to an undergraduate level of knowledge of general relativity which will be assumed
- Course Format (**Extended**: 5 x 2hr lectures)

Course Description:

- Keywords: General relativity, numerical solutions, PDEs, Python
- Syllabus:

In this course we will use a simple python code called engrenage (https://github.com/GRTLCollaboration/engrenage) to illustrate the concepts of numerical relativity - the solution of the Einstein Equation of general relativity on a computer. Such simulations are instrumental in interpreting the signals from gravitational wave detections of merging binary black holes, and provide an example of the techniques employed in the numerical solution of coupled non-linear partial differential equations.

- Recommended reading:

Notes for J Valiente Kroon's LTCC course on Mathematical Topics of General Relativity or other introduction to the 3+1 ADM decomposition of Einstein's equations.

- Additional Optional reading:

Numerical relativity – Starting from Scratch
Thomas W. Baumgarte and Stuart L. Shapiro
https://www.cambridge.org/core/books/numerical-relativity-starting-from-scratch/FB5B832C4ED8EFE65A5834C6D6D4657D

- Prerequisites:

A basic knowledge of python or another coding language will be an advantage. It is recommended that students attend J Valiente Kroon's LTCC course on Mathematical Topics in General Relativity, or read the notes available online, but it should still be possible to follow the course with a basic knowledge of general relativity such as that obtained from an undergraduate course.

Format:

The course will be mainly hands-on exercises using the code, to develop new features or enhancements that illustrate particular concepts. Students should have a python installation including Jupyter Notebooks installed on their laptops before attending the course (see https://jupyter.org). Lecture notes and full solutions will be provided.

The final assessment will involve the development of a new example problem in a Jupyter notebook for submission, and it will be possible to adapt the difficulty depending on the level of experience of the student.

Lecturer Details:

- Lecturer: Katy Clough
- Lecturer home institution: QMUL
- Lecturer e-mail: k.clough@qmul.ac.uk