

Strong Gravity Beyond General Relativity

Supervisor: [Pau Figueras](#)

Research Group: [Geometry, Analysis & Gravitation](#)

Project description:

The detections of gravitational waves produced in mergers of compact objects have revolutionised our understanding of gravity and have given rise to the era of gravitational wave astronomy. With the recent upgrades of the detectors, gravitational wave detections are made on an almost weekly basis. This offers a new opportunity to test Einstein's theory of general relativity in the strong field regime. One of the main challenges in carrying out these tests is that almost nothing is known about the strong field regime of alternative theories of gravity. The aim of this project is to make progress in our fundamental understanding of gravity by precisely studying the strong field regime of certain alternative theories of gravity using black hole binary mergers.

The project will consist of three main lines of research:

1. Many alternative theories of gravity are not known to have a well-posed initial value problem. Therefore, the first goal will be to understand if and how these alternative theories of gravity of interest can be reformulated such that they are well-posed and hence they have predictive power.
2. For the well-posed alternative theories of interest, we will simulate black hole binary mergers using supercomputers and extract the corresponding physical observables, such as gravitational waves. We will then compare with the predictions of general relativity. This will tell us about the types of deviations from general relativity we should be looking for and thus potentially detect them.
3. We will finally study the details of singularity formation in general relativity and in alternative theories of gravity that incorporate quantum corrections (i.e., higher derivatives) to reveal the nature of gravity at its fundamental level. This can allow us to constraint the role of quantum gravity.

Further information:

[How to apply](#)

[Entry requirements](#)

[Fees and funding](#)