

PhD in gravitational wave astrophysics. Application for EUR Spectrum grant.

Title : Binary black hole coalescences with gravitational waves: Where do they come from?

Keywords

High energy astrophysics, compact objects, gravitational waves, star formation and evolution

Description

Gravitational waves are opening a new window on our Universe. The first detections from LIGO and Virgo resulted from unexpectedly massive black holes (>20 Solar masses).

These discoveries raise the questions of how, when and where this binary black holes originally formed. Current models favour the formation through the interactions of massive binary stars formed in low-metallicity environments, but many questions remain about the exact evolution of interacting massive binary stars.

The goal of this thesis is to develop different models to interpret/predict the observed coalescences in terms of host galaxy, and different parameters of stellar/binary evolution. The first analyses will be performed with available catalogs (observing campaigns O1-O2-O3) and most of the thesis will be based on observations during yearlong observing campaign O4, which will happen in 2022. The PhD student will be involved in the international LIGO/Virgo/KAGRA collaboration.

Method:

- Interpretation of the O3 events and prediction of O4 events based on different models for stellar evolution. The student will use a semi-analytic model for star formation with models for binary evolution. The stellar evolution model will be continuously improved during the thesis.
- Interpretation of the events of O4 with a Bayesian analysis method to determine the key parameters describing the evolution of massive binary stars (supernova explosion, mass transfer, stellar winds). The student will develop the method based on pre-existing Python libraries.
- Interpretation in a broader context: Towards the end of the thesis, the properties of the observed coalescences will be compared with other present or future observations of black holes, such as X-ray binaries in the Milky Way or the black holes which will be observed with space-based gravitational wave detector LISA.

Supervision team

This project will be mainly supervised by Astrid Lamberts, who shares her time between the Laboratoire Lagrange (astronomy) and Artémis (gravitational waves), both in Nice. The student will be encouraged to spend time in both departments. Marie-Anne Bizouard (Artémis) will be involved in the setup of the bayesian analysis and the integration of the student within the LIGO/Virgo/KAGRA collaboration.

Funding

Astrid Lamberts will apply for specific funding for this project through the EUR SPECTRUM at the Université Côte d'Azur. This highly competitive funding scheme is geared towards young researchers like Astrid Lamberts.

It offers an attractive salary to the PhD student (~1950 euros netto/month).

Profile of the student

A master degree in Astronomy/Astrophysics and a working understanding of English are required. We are looking for a motivated student, who is eager to learn and ready to work at the interface of different fields in astronomy.

A working knowledge of Python and statistics would be a plus.

Application

Students interested in this project should get in contact with Astrid Lamberts (astrid.lamberts@oca.eu) as soon as possible for preliminary discussion/selection before the formal deadline (April 6th).

Students should provide

- a CV
- a list of previous grades (Bachelor and Master)
- 2 letters of recommendation
- a cover letter