

Internship(s) - Searches for kilonovae in gravitational waves phenomena - M1, M2 February 2022 → End July 2022

Kilonovae are the optical signatures of extreme events such as the coalescence of two neutron-stars. They are due to the thermal radiation in the near-by ejecta of the event, thermalized by the radioactive decay of freshly synthesized elements. Over the last 10 years, several claims of observations have been reported in the literature. But only in 2017, a clear signal of a kilonova, AT2017gfo, was observed due to a very intensive campaign monopolizing more than 70 international telescopes. The “lanceur d’alerte” came from gravitational waves (detected by the LIGO-Virgo collaboration), also emitted during binary neutron star coalescences. The next observing run of gravitational waves will start in December 2022. It promises to detect several binary system coalescences for which we might expect an associated kilonova signal. The GRANDMA network embeds more than 25 telescopes covering all time zones and both hemispheres. Over the last 3 years, GRANDMA has demonstrated its observational expertise to search for counterpart of gravitational wave events as kilonovae.

Proposition 1 - In this internship, we will master the joint observational plan of the GRANDMA collaboration (<https://github.com/mcoughlin/gwemopt>). The current version of the algorithm is able to provide individual plans to various telescopes to efficiently cover the search area of gravitational waves events. The work in the internship will develop the filtering system (pre-processing) to establish a score of interest of the gravitational wave alerts. This score will be based on information provided by the gravitational wave signal and expected brightness of the electromagnetic signature. To do this, it will use a multi-physics framework developed by members of the GRANDMA collaborations. The score will allow us to ponder where, when and which telescopes should be used to produce an adequate observation plan.

Location of the internship - Artémis (Nice) - contact Sarah Antier (sarah.antier@oca.eu)

Proposition 2 - In this internship, we will realize the online data reduction performed once observations are made in GRANDMA during gravitational-wave follow-up. To do this, two dedicated prototypes analyses are developed (see MUPHOTEN and STDPIPE <https://gitlab.in2p3.fr/icare>). They are able to estimate the image background, perform the subtraction of a reference image and extract the magnitude of the detected transients. If no transient can reliably be identified as the gravitational-wave counterpart, the pipeline can establish the limiting magnitudes (sensitivity) in the image. The work during the internship will consist of 1) creation of a validation process in terms of quality of the image (pre-processing), 2) comparison of the two methods to derive a global measurement, and 3) integration of the prototypes into the GRANDMA framework to provide temporal properties of the kilonovae.

Location of the internship - IJCLAB (Orsay) ou Artémis (Nice) - Contact Antier (sarah.antier@oca.eu) et Hello (hello@ijclab.in2p3.fr)

These internships are of interest for those who want to connect with high-energy astrophysics observations and online analysis, and desire to be involved in emerging astrophysics techniques in a collaborative and international context.