Observational scheduling and Physics of the Violent Universe

in the framework of the GRANDMA – LSST/FINK collaboration

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Key words: Data Analysis – Monte-Carlo Simulations – Astrophysics –

Python – clusters - gitlab

In the context of the GRANDMA (https://grandma.lal.in2p3.fr/) project, we would like to propose an internship from February/March to August 2021 (or a subset of this period) to a student with strong skills on computing (Python, C++) on physics (signal and image processing), and interesting in the astronomy and astroparticle fields.

Global Rapid Advanced Network Devoted to the Multi-messenger Addicts (GRANDMA) is a network of 25 telescopes spread all over the world, with both spectrometry and photometry facilities. Mostly robotics, they are able to quickly follow-up transient events from the sky, connected the Violent Universe such as collapse of massive stars or neutrons star coalescence. Events can be observed via their short timescale multi-wavelength signature as well emission from gravitational waves.

The Legacy Survey of Space and Time (LSST), a 8-m telescope under construction in Chile will survey the southern sky deeper and faster than any wide-field survey to date from 2022. LSST will enable the discovery of an unprecedented large number of astrophysical transients connected to the violent universe, sending several million alerts per night that will be collected and processed by the filtering system Fink (https://fink-broker.org/). However, the cadence of the telescope will not be sufficient to fully characterise the source, and we will need to tightly coupled the information from Fink with observations provided by the GRANDMA network to qualify and quantify the nature of the sources.

In preparation of the gravitational astronomy, we propose to use the LSST stream of alerts to optimise the observational strategy of the GRANDMA network to provide additional observations connected to kilonovae, gamma-ray burst (GRB) afterglow, and electromagnetic signature of gravitational events.

Physics subject:

This work will make use of simulated events of kilonovae/GRB afterglows, and simulated LSST streams as well as current alert streams sent by the ZTF telescope. The student will estimate the best observational strategy to quickly identify the nature of the transients. The work will be implemented in Python using two existing previous work and packages (https://github.com/mcoughlin/gwemlightcurves, https://arxiv.org/abs/1912.06383)

Regarding the competencies and interests of the student, the internship can be oriented to:

Engineering and Computer Science topics

The work will use machine learning algorithms on simulated and real data.

It will also consist to establish the machinery for re-injecting the GRANDMA observations into the Fink broker and create a specific filter to distinguish GW electromagnetic sources from others.

For the student, the internship offers an opportunity to be involved in a fantastic project of astronomy and he/she will be integrated on an international team. The student will also have the opportunity to improve his/her computing skills and to develop a rigorous scientific approach.