M2 Internship Subject (2024-2025) at Institut Pluridisciplinaire Hubert Curien (IPHC)
Department of Subatomic Research (DRS)

OGMA Team / Virgo

Effects of the astrophysical prior/assumptions when searching for Gravitationnal Wave events

The OGMA Team (**O***bservations with* **G***ravitational waves &* **Mu***ltimessenger* **A***stronomy*) is involved in High Energy Neutrino Astronomy (KM3NeT neutrino telescopes) and Gravitational Wave (GW) Astronomy, with technical contributions to the Virgo interferometer plus the analysis of the LIGO, Virgo and KAGRA data, for what concerns GW astronomy. The team is also involved in the low latency operations, leading to public alerts and enabling MultiMessenger astronomy.

GW astronomy is a new field started a few years ago with the first observation of GW in 2015. It has been followed two years later by the first observation of GW plus electromagnetic signals (GRB, optical, radio). Since then, this field is rapidly evolving, thanks to the improvement of the detectors and new data taking, with more than 240 events observed so far (Oct. 2024). Currently, the LIGO and Virgo detector are jointly operated for the observation run, named "O4". They are detecting GW events at a typical rate of few events per week.

The OGMA Virgo group is involved in the search for GW events from the merger of compact objects (black holes BH and/or neutron stars NS), for realtime analyses and for the production of signal catalogues, through the development of the analysis pipeline MBTA. This pipeline is providing candidate events to a common LIGO/Virgo infrastructure which publicly broadcast the most significant candidates. The team is also involved in the validation and release of these public alerts.

The topic of the proposed internship is to explore the impact of some astrophysical hypothesis made when searching for GW events with the MBTA pipeline. For instance, the spin of the black holes is not expected to be the same for a stellar black hole (i.e., issue from the collapse of a massive star), or for a black hole resulting from the merger of two stellar black holes. Optimizing these parameters for the search could help collecting more events and improve our knowledge of the astrophysical sources. For the here above example, it could contribue to the understanding of the possible hierarchical formation process for (super) massive black holes. With the ongoing O4 observing run, this internship is a good opportunity to discover Data Analysis in GW experiments and participate to the developments of this research field.

This work could be extended and enlarged during a PhD Thesis.

Internship Supervisor(s) :**AUBIN Florian, MOURS Benoit**
Phone : **+33 (0)3 88 10 6209** - Email : benoit.mours@iphc.cnrs.fr. IPHC Batiment 21 / Bureau 211
Composition of OGMA - Scientific Contact T. Pradier (thierry.pradier@iphc.cnrs.fr, University Staff, Virgo/KM3NeT), A. Albert & D. Drouhin (University Staff, KM3NeT), F. Aubin (CNRS Post-doc, Virgo), B. Mours (CNRS Staff, Virgo), T. Sainrat (PhD, Virgo), P. Van Hove (CNRS Staff, Virgo), plus technical staff for the detector developments.