Thesis abstract T. Hussenot-Desenonges

"Time-Domain Astronomy in the Multi-Messenger Era: From observations to analyses."

Core-collapse supernovae and compact binary coalescences are two classes of high-energy astrophysical phenomena with transient multi-messenger signatures: gravitational waves (GW), gamma-ray bursts (GRB) accompanied by their multi-wavelength afterglows, and respectively supernova and kilonova emissions (thermal radiation of ejecta heated by the radioactive decay of mainly nickel-56 for the former and r-process lanthanides for the latter) at UV, optical and infrared energies.In order to study the complex physical processes (magnetohydrodynamics, behavior of high-density nuclear matter, etc.) that generate these emissions, many multi-messenger observations such as the landmark GW-GRB-kilonova detection of August 17th 2017 are needed.
In parallel to the improvement in detection of GWs with the LVK detectors and of GRBs with many gamma-ray satellites, many observation facilities have been developed to follow up multi-messenger alerts. I present the GRANDMA collaboration's telescope network dedicated to the follow-up of these high-energy events, and describe its observing strategies to respond rapidly to GW and GRB alerts.I discuss the process of photometric analysis of telescope images, which I applied in the GRANDMA studies of GRBs 221009A and 230812B, paying particular attention to the multiple error contributions to the magnitude uncertainties.
I then discuss the process of Bayesian parameter inference, which compares a model to observational data in order to extract constraints on the source's physical parameters (e.g. distance, ejecta masses...). I highlight the systematic uncertainty parameter as an important metric for the discrepancy between model and data, and study the expected information gain when analysing kilonovae observed with different telescope cadences.
Finally I showcase the parameter inference analyses of a few remarkable GRBs and kilonovae. I discuss the data-model tension in analyses of the AT1027gfo kilonova, and I highlight the use of Bayesian inference for model selection: for example, a kilonova scenario is favored over a supernova scenario to explain the excess afterglow of GRB 211211A.