Thesis subject

Name of the laboratory: Laboratoire d'Astrophysique de Marseille

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Subject's title: Modeling electromagnetic counterparts of gravitational-wave sources

Subject description:

The first detection of a gravitational-wave (GW) source by the *Laser Interferometer Gravitational-Wave Observatory* (LIGO; Abbott *et al.* 2016) has opened up the new branch of GW astronomy. The subsequent detection of an electromagnetic signal from the collision of two neutron stars (NS; Abbott *et al.* 2017; Coulter *et al.* 2017) constituted the first observation of a "kilonova" event and enabled an unprecedented opportunity to constrain the explosive nucleosynthesis of heavy *r*-process elements such as gold (Au) or platinum (Pt). Such kilonova events are powered by the radioactive decay of several 0.01 solar masses of heavy nuclei, leading to the emission of γ- and X-rays, some of which are reprocessed into optical and infrared photons. Modeling the radiative signature of kilonovae is complicated by the lack of complete nuclear and atomic data for heavy *r*-process elements and by viewing-angle effects related to the ejecta geometry. Useful constraints on the ejecta mass, bulk velocity, and composition can nonetheless be obtained via radiative-transfer modeling. In this thesis, the student will develop a 3D Monte Carlo radiative-transfer code to constrain the ejecta geometry of mergers involving at least one neutron star through modeling of their hard radiation (γ- and X-rays). She/he will also use the state-of-the-art 1D radiative-transfer code CMFGEN (Hillier & Dessart 2012) to model the optical and infrared radiation (light curves and spectra). She/he will become a member of the *Electromagnetic counterparts of gravitational wave sources at the Very Large Telescope* (ENGRAVE) international collaboration[1] and have the opportunity to become involved in the preparation of the future *Laser Interferometer Space Antenna* (LISA) ESA mission[2].

[1] http://www.engrave-eso.org/
[2] https://www.elisascience.org/