Characterization of the coronagraphic method for the rapid localization of supermassive black holes for the LISA mission

Since 2015, the first gravitational waves (GW) detection has opened a new window on the Universe. LISA, spatial interferometer project, (Laser Interferometer Space Antenna) will be able to measure GW in a new frequency range (from 10^{-5} to 1 Hz). Many signals from different sources will be reachable : Black Holes (Super Massive, Stellar Mass, Extrem Mass ratio), Galactic binaries and stochastic background from primordial Universe.

Laser beams is exchanged from a spacecraft to another one in the triangular LISA constellation. Inter-spacecraft distance are measured by interferometry techniques to reach a relative variation about 10^{-21}. In the LISA data, waveform signatures are specific to the gravitational sources. The waveform data analysis will allow to determine source parameters (coalescence time, position, masses, spins, ...). The objective will be to provide a gravitational sky catalog.

LISA team at LPCCaen is developing a coronagraphic method for an efficient localization of gravitational wave sources. Rapid detection of the coalescence of super-massive objects will permit to trig an alert to the “traditional” observatories to observe the electromagnetic counterparts. This work is in line with the objectives of the LLAP (Low Latency Alert Pipeline) working group of the LISA Consortium.

The goal of this thesis will be to qualify the coronagraphic method for locating super-massive black holes (MBHB) using the LISA constellation. The aim will be to integrate the algorithm into the LLAP pipelines.
The student will have to :

- participate in the production of reference simulation data to evaluate LLAP algorithms,
- initiate a study of the instrument's background noise level incorporating realistic assumptions,
- construct the TDI variable derived from $\boldsymbol{\kappa}$ from coronographic method and propose an evaluator of the method itself,
- study solutions to control the impact of gaps and glitches in the parameters estimation of gravitational-wave sources as the source location (*lambda*, *beta*),
- alert and evaluate the positionning potential of the binary system for large-scale EM wave measurement projects during MBHB coalescence.

The Phd student will have the opportunity to present her/his work to the LISA Consortium groups and at international conferences.

The expected skills of the student are: solid background in physics and programmation (Python, C/C++) for simulation and data analysis. Knowledge in astrophysics and signal waveform data analysis will be appreciated.

Encadrant : Dr Yves Lemière
Directeur de Thèse : Pr François Mauger (HDR)
lemiere@lpccaen.in2p3.fr
02 31 45 29 64

Laboratoire de physique Corpusculaire
6 bvd Maréchal Juin 14050 Caen
Cedex 4