DESIGNING THE NEW DETECTOR OF GRAVITATIONAL WAVES

LABORATORY : Institut Lumière Matière

LEVEL : M1 / M2
TEAM(S) : SOPRANO

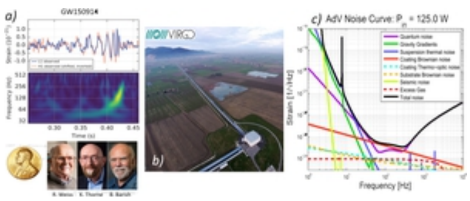
CONTACT(S) : CAGNOLI Gianpietro

CONTACT(S) DETAILS: gianpietro.cagnoli[at]univ-lyon1.fr / Tel. 0472448568

KEYWORD(S) : Gravitational Waves / Virgo / Einstein Telescope

SCIENTIFIC CONTEXT :

The first detection of Gravitational Waves (GW) in 2015 [1] opened a new window on the Universe. The new born field of GW Astronomy has claimed already about 80 GW signals coming from ultra-high energetic events involving Black Holes and Neutron Stars and now all the 5 GW detectors around the World are going through major upgrades to become more sensitives [2].



a) GW first detection, b) Virgo, c) noise curves calculated with GWINC

Sensitivity is improved reducing the noise coming from different processes. Fluctuation of the structure and temperature of the different components of the interferometer (thermal noise); quantum processes both in light detection and in interaction with mirrors; seismic noise; fluctuations of the local gravity field, these are just few of the many noise sources that hide the GW signal. The GW community has developed a computing code called GWINC [3] that contains the physics of all these processes and all the relevant parameters of the detector (~100) are considered as input. GWINC is continuously evolving and it is used to assess the performance of any working detector (LIGO, Virgo, KAGRA) and future projects (Einstein Telescope, Cosmic Explorer).

MISSIONS :

The new European project for GW detection is called Einstein Telescope (ET) and it will be built in the decade of the 30s. This detector will contain different interferometers, some of them at cryogenic temperatures. The group g-MAG at iLM is developing the technology of sapphire for the cryogenic operation but it is not clear at which temperature the mirror noise is the lowest. The selected candidate has to find the optimum working temperature studying the physical phenomena at the origin of all noise sources present in GWINC.

The search of the optimal working point is not a simple process because of the complexity of the detector but also because at each frequency detection band corresponds a different GW source. That means a detector optimized for large mass Black Holes Binaries is not optimal for Neutron Star merging. The candidate should like to master different physical phenomena (quantum, statistical physics, optics, condensed matter) and be interested on learning the basic astrophysical properties of GW sources. At the end of the stage the selected candidate will acquire a solid background knowledge to enter the new field of GW Astronomy.

OUTLOOKS :

This internship could be continued with a PhD work.

BIBLIOGRAPHY :

[1] https://fr.wikipedia.org/wiki/GW150914

[2] https://gwic.ligo.org/

[3] https://ligoindia.physics.gla.ac.uk/buildadetectorworkshop/pygwinc/
https://git.ligo.org/users/sign_in

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