INTERNSHIP PROPOSAL

Laboratory name: Laboratoire d'Annecy de Physique de Particules (CNRS/LAPP)
CNRS identification code: UMR 5814
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Internship location: CNRS/LAPP, 9 Chemin de Bellevue, 74940 Annecy

Thesis possibility after internship: YES
Funding: POSSIBLE via selection at Ecole Doctorale de Physique de Grenoble)

High-sensitivity interferometry for the development of crystalline coatings dedicated to gravitational wave detectors

The first detections of gravitational waves from the coalescence of black holes, announced by the LIGO-Virgo collaboration in 2016, opened the field of gravitational astronomy. The first detection of a gravitational wave from the coalescence of two neutron stars in coincidence with a gamma-ray burst paved the way for multi-messenger astronomy. Since then, more than 300 events have been detected by the LIGO and Virgo detectors. These detectors are based on a Michelson-type laser interferometer whose arms, several kilometers long, undergo a small change in length when a gravitational wave passes through. In the frequency region where the detector is most sensitive, around 100 Hz, the main limitation comes from the thermal noise of the mirrors that make up the interferometer. For this reason, scientists are seeking to create mirrors with lower thermal noise. One research avenue involves using single-crystal materials based on III-V materials of the type used in electronics.
To achieve this, the LAPP Virgo group is coordinating a project funded by the ANR (French National Agency for Research and Innovation) in collaboration with the CEA in Grenoble, the LMA in Lyon, and two companies in the Paris region. LAPP's role is to develop an optical bench capable of measuring the thermal noise of these mirrors in order to guide their development. The measurement is based on a very high-finesse optical cavity. The cavity must be illuminated with a laser beam whose frequency is modulated to excite several cavity modes simultaneously. Measuring the variation in the resonant frequencies of these modes makes it possible to deduce the thermal noise to be measured. The interferometry technology used is similar to that used in the Virgo project. The challenge lies in the low amplitude of the thermal noise, which requires a bench with very high sensitivity, capable of measuring thermal noise without being limited by environmental and laser noise. The proposed internship focuses on the development and operation of this measurement bench. The bench is installed at LAPP and its development benefits from the expertise developed in Annecy in the field of gravitational wave detection for more than three decades. It should be noted that such a high-sensitivity optical bench can also be used to measure the thermal noise of mirrors based on other technologies. The student will therefore work on a versatile optical bench.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics:	YES	Soft Matter and Biological Physics:	NO
Quantum Physics:	YES	Theoretical Physics:	NO