



ERASMUS MUNDUS



# MASTER IN PHOTONICS – PHOTONICS BCN EUROPHOTONICS-POESII MASTER COURSE

## PROPOSAL FOR A MASTER THESIS

**Dates: April - September 2017**

**Laboratory : Gravitational Astronomy Group**  
**Institution: Institut de Ciències de l'Espai (IEEC-CSIC)**  
**City, Country : Bellaterra, Spain**

**Title of the master thesis: Optomechanical resonators for temperature sensing in space-based gravitational wave detectors**

**Name of the master thesis supervisor: Miquel Nofrarias**

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### **Summary of the subject:**

Gravitational waves are a prediction of Einstein's General Relativity recently detected by on-ground laser interferometers. LISA (Laser Interferometer Space Antenna) is an ESA proposed mission designed to detect gravitational waves in space, aiming to detect gravitational radiation by putting three satellites in heliocentric orbit separated 1 million km one from each other, forming a triangle. The Gravitational Astronomy group at the Institut de Ciències de l'Espai (IEEC-CSIC) has provided the Data and Diagnostics Subsystems of LISA Pathfinder, a precursor mission launched in December 2015 and currently in operations, which has successfully measured the residual acceleration of two free-falling test masses in space down to the  $5 \times 10^{-15} \text{ m/s}^2/\sqrt{\text{Hz}}$  in the milliHertz band [1].

Our group is currently developing the techniques required for future gravitational wave detectors in space. A particular interesting challenge is the high stability control of temperature in the very low-frequency range (below the milliHertz). For that purpose we are investigating temperature sensing by means of phase locking to optomechanical resonators [2].

The candidate will work in the implementation of the Pound-Drever-Hall technique that will be used to stabilise the frequency of the laser to the resonator, acting as an optical cavity.

**Keywords : Gravitational Waves, Optomechanics, Temperature noise**

**Additional information :**

- Required skills : knowledge on optics, electronic instrumentation, signal processing, and control loops.
- Miscellaneous :

[1] M. Armano et al. Sub-Femto-g Free Fall for Space-Based Gravitational Wave Observatories: LISA Pathfinder Results, *Phys. Rev. Lett.* 116, 231101 (2016)

[2] W. Weng Nano-Kelvin Thermometry and Temperature Control: Beyond the Thermal Noise Limit, , *Phys. Rev. Lett.* 112, 160801 (2014)