# ***INTERNSHIP PROPOSAL***

*(One page maximum)*

Laboratory name: Laboratoire d'Annecy-le-Vieux de Physique Théorique, LAPTh
CNRS identification code: UMR5108
Internship director'surname: Calore
e-mail: calore@lapth.cnrs.fr Phone number: 0450091692
Web page:
Internship location: LAPTh, Annecy ou IPAG, Grenoble selon les contraintes de la/du candidate

Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ED Grenoble

**The Fermi gamma-ray excess: new physics at the Galactic centre?**

Summary (half a page maximum)

The excess of gamma rays detected by the Fermi-LAT telescope, first observed more than 15 years ago at the centre of our Galaxy, remains one of the most fascinating mysteries in astrophysics. Its origin remains unknown and continues to fuel much debate: could it be the first signal from dark matter, or is it the sign of an as yet unknown population of gamma-ray emitters?
Millisecond pulsars (MSPs), rapidly rotating neutron stars located in the Galactic bulge, are among the most promising candidates for explaining this excess. These old objects are mainly identified by deep radio surveys, but understanding their distribution and emission mechanisms is a complex challenge.
Given the wealth of data available, advanced statistical techniques are required to reveal the underlying properties of MSP populations, in particular their spatial and luminosity distribution in the Galaxy. This is where machine learning comes in, offering a revolutionary approach to analysing and interpreting this abundance of data.
Tasks of this internship:
1) Theoretical modelling: Theoretically modelling of the pulsar population in the Galaxy, including its components and expected radio-band emissions, taking into account their potential contribution to the gamma-ray excess detected by Fermi.
2) Simulations: Development of numerical simulations of MSP populations in the Galaxy, taking into account the selection effects of radio telescopes.
3) Statistical inference: Design and implementation of a robust statistical framework, based on machine learning techniques, to infer the properties of the MSP population.
4) Comparison with data: Comparing the results of the simulations with real data from large radio surveys in order to gain a better understanding of these enigmatic sources.
By combining astrophysics, statistics and machine learning, this project aims to bring us closer to solving the Fermi excess enigma, with the possibility of discovering the first evidence of dark matter.
Environment:
The internship will be carried out in collaboration with the Astrophysics and Cosmology team at LAPTh and the Sherpas team at IPAG, with co-supervision by M. Clavel. The internship could take place in Annecy or Grenoble, depending on the candidate's constraints.

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

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