EUROPHOTONICS-POESII MASTER COURSE

PROPOSAL FOR A MASTER THESIS

Dates: April 1st, 2016 – September 30th, 2016

Laboratory : ICFO-Institut de Ciències Fotòniques
City, Country :Castelldefels, Barcelona

Title of the master thesis: Cold atoms and cold ions as a platform to study quantum many body phenomena

Name of the tutor of the master thesis : Maciej Lewenstein
Email address :Maciej.lewenstein@icfo.es
Phone number : 626723233
Mail address : Carrer Veciana 19, 08023 Barcelona

Summary of the subject (maximum 1 page) :

Cold atoms and cold ions are amazing systems that can be controlled in the laboratories in an unprecedented way and can serve to study/mimic various models of condensed matter and even high energy physics. Most amazingly one can reach in such systems quantum mechanical states that are very strongly correlated and exhibit very exotic, yet useful properties. Super-fluidity, superconductivity, topological order are only few examples from a large list of models and phenomena that can be studies with cold atoms and ions. Lewenstein's group at ICFO has a long tradition of working on these problems and belongs to the leading groups in the world.

We propose as a subject of the master thesis a study that focus on properties of ultracold bosonic or fermionic systems in an optical lattice. Such systems are typically described by various kinds of the so called Hubbard models, but the validity of these conventional models is being frequently questioned with the advent of more precise and controlled experiments with atoms. We propose to look at simple1D systems of mixtures of fermionic and bosonic and examine the validity of Hubbard approach there and possible effect going beyond. The project will combine analytic calculations with numerical simulations using the state-of-art codes.

Keywords :
Quantum Many Body Systems, Cold Atoms, Cod Ions,

Additional information :

* Required skills: Good knowledge of the methods of the theoretical physics (from classical mechanics, through electrodynamics, quantum mechanics, statistical physics, if possible quantum field theory)
* Miscellaneous: