

# **EUROPHOTONICS-POESII MASTER COURSE**

## PROPOSAL FOR A MASTER THESIS

Dates: April 1<sup>st</sup>, 2016 – September 30<sup>th</sup>, 2016

Laboratory: Quantum Information theory group City, Country: Barcelona, Spain

Title of the master thesis: Equilibration in systems with long and short-range interactions

#### Name of the tutor of the master thesis: Antonio Acín

Email address : <u>antonio.acin@icfo.es</u> Phone number : +34 935534062 **Name of the cotutor of the master thesis : Senaida Hernández** Email address : <u>senaida.hernandez@icfo.es</u> Phone number : +34 935534063 Mail address : Mediterranean Technology Park,Av. Carl Friedrich Gauss, 3,08860 Castelldefels (Barcelona).

#### Summary of the subject (maximum 1 page):

Understanding the quantum mechanical dynamics of pieces of matter is important for developing new materials. It is the subject of condensed matter physics, in which such materials are described by relatively simple toy models that, for example, capture the essential features of electrons moving around in a crystal or the dynamics of small magnetic moments (spins) in a magnet.

Such models are usually defined on a lattice and the interaction is captured with a quantum Hamiltonian that is a sum of all the interactions between the particles. These interactions are characterized in terms of their support, that is, the region of sites on which they act. Two scenarios are possible: The interactions are short-range when their support is small (for example, only nearest neighbours interact) and they are long-range when their support is arbitrarily big but becoming weaker with the distance. In this project we want to study the dynamics of both short-range and long-range Hamiltonians. In particular, we want to understand how much time such a system needs to equilibrate and how the properties of the equilibrium state depend on the type of interactions.

Keywords : Lattices, local hamiltonian, short-range, long-range, equilibration, time scales

### Additional information :

\* Required skills : Basic knowledge of quantum physics, programming in Mathematica or Python

\* Miscellaneous : This is a project with a strong connection to current research activity