Master 2 "Systèmes Complexes, Optique, Lasers (SCOL)": Research Training 2022-2023

Appel à sujet de stage recherche / Call for research training subject

Laboratory: PhLAM

Supervisor: Adam Rançon
Tél : 03 20 43 69 86, E-mail : adam.rancon@univ-lille.fr

Collaborator(s): Ivan Balog (Zagreb), Nicolas Dupuis (Paris)

Topic: Cold atoms

Master 2: select the master and the most appropriate option

x Master 2 SCOL	□ Master 2 MME (GP-SCP)
x Option Complex Systems (GP-IKS)	□ Option Condensed Matter
	□ Option Condensed Matter/Pharma
	□ Option Dilute Matter and Spectroscopy
	□ Option Atmospheric Sciences
	□ Option Modeling at the molecular & atomic scales

The superfluid—Bose-glass transition from the functional renormalization group

Understanding the interplay between interactions and disorder is one of the major challenges in condensed matter physics. For interacting bosons, describing superfluid helium and cold atoms experiments, disorder induces a quantum phase transition from a superfluid to a localized phase, the Bose glass. The properties of this phase, and the transition itself, have yet to be qualitatively understood theoretically, although recent progress have been made using numerical simulations. . There are still many open questions about this transition, such as a theoretical characterization of the critical exponents, especially the dynamical exponent (which has been conjectured to be equal to the number of dimensions of the system), or the existence of an upper critical dimension.

A promising avenue is to use the Functional Renormalization Group (FRG), a modern version of Wilson's RG, which allows for non-perturbative approximation schemes. The goal of the internship, which could be followed by a PhD thesis, is to study the superfluid —Bose-glass transition in the framework of the FRG. This will involve deriving the FRG flow equation in an appropriate approximation scheme and solving the corresponding integro-differential equations. Beyond characterizing the transition, this should also shed light on the properties of the Bose glass phase.

Key words: cold atoms, superfluids, Bose glass, quantum phase transitions, renormalization group