Master 2: *International Centre for Fundamental Physics*

INTERNSHIP PROPOSAL

Laboratory name: Laboratoire Kastler Brossel (LKB)
CNRS identification code: UMR 8552
Internship director'surname: Nicolas Cherroret
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Web page: https://sites.google.com/site/nicolascherroret/
Internship location: Sorbonne Université, Paris

Thesis possibility after internship: YES
Funding: YES

Title: The route to thermalization in disordered Bose gases

When perturbed from an equilibrium state, many-body quantum systems experience a more or less complicated temporal evolution before eventually returning to equilibrium at long enough time. For non-integrable systems, this final state is usually characterized by a thermodynamic ensemble (thermalization). This process arises in the absence of any external thermal « bath », the interacting system itself serving as a bath for all its subparts. The dynamics leading to the thermal state can be very rich, associated with a variety of intriguing phenomena, such as pre-thermalization, non-thermal fixed points, dynamical phase transitions and so on.

The general context of this M2 internship is the *theoretical description* of the out-of-equilibrium dynamics of a *disordered* Bose gas following a quench of the particle interaction. This problem was previously addressed by our group, with emphasis on the competition between weak localization effects in disorder and interactions [1], as well as the emergence of a pre-thermal regime at short time [2,3]. The main objective of the internship will be to explore the quench dynamics of a 2D disordered Bose gas in a situation where the disorder is typically « stronger » than the interactions. In this regime, we will explore both the impact of interactions on weak localization, following previous works by the team [1], and the interplay between interactions and Anderson localization via the phenomenon of coherent forward scattering [4].

The intern will be supervised by Nicolas Cherroret in the Complex Quantum Systems group of LKB (http://www.lkb.upmc.fr/complexquantumsystems/). The project will involve both numerical and analytical analyses. The analytical approach will be based on quantum kinetic equations for non-equilibrium disordered Bose gases.

[1] T. Scoquart, T. Wellens, D. Delande, N. Cherroret, Phys. Rev. Res. **2**, 033349 (2020).
[2] T. Scoquart, P.-E. Larré, D. Delande, N. Cherroret, Europhys. Lett. **132** (2020) 6600.
[3] N. Cherroret, T. Scoquart, D. Delande, Annals of Physics (2021) 168543.
[4] T. Karpiuk, N. Cherroret, K. L. Lee, B. Grémaud, C. A. Müller, C. Miniatura, Phys. Rev. Lett. **109**, 190601 (2012)

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

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