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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Internship location: Sorbonne Université, Paris

Thesis possibility after internship: YES
Funding: YES, via EDPIF

Quench dynamics of inhomogeneous interacting Luttinger liquids

Understanding the mechanisms at stake when a many-body system is driven out of equilibrium is a central challenge in quantum physics. In this context, a typical protocol consists in suddenly changing a parameter of an isolated quantum gas, a process called quantum quench. Following the quench, the local observables initiate an out-of-equilibrium evolution and, eventually, relax into a thermodynamic phase captured by conventional equilibrium statistical physics. How this long-time equilibrium is reached is, however, a nontrivial problem in general, involving mechanisms that require the development of specific methods able to faithfully capture dynamical effects.

During this M2 internship, we will study the quench dynamics of one-dimensional quantum gases described by the interacting Luttinger-liquid model [1]. Precisely, we will aim at characterizing the relaxation of an initial inhomogeneity of the quantum gas up to its final thermalization, a typical scenario considered in state-of-the-art experiments. This relaxation is governed by phonon-phonon interactions, which exhibit peculiar properties in that system [2].

The project will be conducted at Laboratoire Kastler Brossel in Sorbonne Université, within the "Quantum Theory, Atoms and Fields" group. It will involve a mixture of theoretical and numerical methods [3], such as non-equilibrium QFT calculations, derivations of quantum kinetic equations and their numerical resolutions.

[1] M. Buchhold, S. Diehl, EPJD **69**, 224 (2015).
[2] M. Kulkarni and A. Lamacraft, Phys. Rev. A **88**, 021603(R) (2013).
[3] C. Duval, N. Cherroret, Phys. Rev. A **107**, 043305 (2023).

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