

Spécialité de Master « Optique, Matière, Paris »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage

Date de la proposition :

Responsable du stage / internship supervisor:

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Nom du Laboratoire / laboratory name: Center for Theoretical Physics of Ecole Polytechnique

Code d'identification : UMR7644 Organisme : Ecole Polytechnique and CNRS

Site Internet / web site: <http://www.uquantmat.fr>

Adresse / address: route de Saclay, F-91128 Palaiseau

Lieu du stage / internship place: Palaiseau

Titre du stage / internship title: Far-from-Equilibrium Dynamics in Ultracold Quantum Systems

Understanding how a strongly-correlated quantum system evolves when driven out of equilibrium is presently a central challenge to quantum physics. It would deeply impact our fundamental understanding of quantum matter and promise fascinating applications to quantum communications. At the moment, we lack a universal picture and many questions remain open.

In this context, ultracold atoms are particularly interesting for it is now possible to investigate many far-from-equilibrium properties of these systems thanks to accurate time-dependent control of the physical parameters [1,2]. In practice, one can prepare the gas in some initial state, then abruptly change Hamiltonian parameters, and observe the subsequent dynamics. Whether the system will evolve towards thermal equilibrium or a more complicated stationary state remains largely an open question. One dimensional systems are particularly fascinating when they are integrable and are thus enable to reach thermal equilibrium. Fortunately, the peculiarities of one-dimensional systems make them amenable to a variety of powerful analytical [3] and numerical techniques [4,5].

The aim of the internship and the thesis is to develop a new approach based on Bethe ansatz, which has been proposed recently and pave the way to exact solutions of far-from-equilibrium problems. It will be applied to the dynamics of one-dimensional bosons with arbitrary strong interactions, for instance release from a trap and relaxation towards equilibrium. Possible extensions with enormous potential include generalizations to Fermi systems and long-range interactions. A part of the project may be developed in direct collaborations with experiments.

[1] J. Eisert, M. Friesdorf & C. Gogolin, Nature Phys. **11**, 124-130 (2015).

[2] S. Trotzky, Y-A. Chen, A. Flesch, I. P. McCulloch, U. Schollwöck, J. Eisert & I. Bloch, Nat. Phys. **8**, 325-330 (2012).

[3] T. Giamarchi. *Quantum Physics in One Dimension* (Carendon press, Oxford, 2004).

[4] F.Verstraete & J.I.Cirac, Phys. Rev. Lett. **104**, 190405 (2010).

[5] G. Carleo, L. Cevolani, L. Sanchez-Palencia & M. Holzmann, Phys. Rev. X **7**, 031016 (2017).

Ce stage pourra-t-il se prolonger en thèse ? Possibility of a PhD ? : OUI / YES

Si oui, financement de thèse envisagé/ financial support for the PhD: Nous consulter / Consult us

Lumière, Matière, Interactions

YES

Lasers, Optique, Matière

YES