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*:

Nom / *name*:	SANCHEZ-PALENCIA	Prénom/ *first name* :	Laurent
Tél :	+33 1 69 33 42 13	Fax : +33 1 69 33 49 49	
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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 Utracold Quantum Systems**

Far-from-Equilibrium Dynamics in Utracold 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 a variety of 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 unable to reach thermal equilibrium. Fortunately, the peculiarities of one-dimensional (1D) systems make them amenable to a variety of powerful analytical [3] and numerical techniques [4,5].

The aim of the internship and thesis will be to theoretically investigate the propagation of information in 1D quantum system. We will study the behavior of correlations and entanglement in the limit of strong interactions, relevant to the modern experiments on ultracold atoms. Following previous studies of us [6-8], we will focus on novel situations where known theorems break down, for instance in the presence of long-range interactions, which are relevant to experiments on molecular condensates or ion systems for instance. These fundamental issues will be addressed from a theoretical point of view, using the most modern *N*-body approaches, both analytical and numerical, for instance using Matrix Product States approaches.

[1] J. Eisert, M. Friesdorf & C. Gogolin, Nature Phys. **11**, 124-130 (2015).
[2] S. Trotzky *et al.*, 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).
[6] L. Cevolani, G. Carleo, and L. Sanchez-Palencia, Phys. Rev. A **92**, 041603(R) (2015).
[7] L. Cevolani, G. Carleo, and L. Sanchez-Palencia, New J. Phys. **18**, 093002 (2016)
[8] L. Cevolani *et al.*, Phys. Rev. B **98**, 024302 (2018) [selected as Editor's suggestion].

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**