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

Quantum entanglement across dynamical phase transitions

In the non-equilibrium physics of isolated many-body systems, dynamical phase transitions (DPTs) have recently sparked considerable interest, as examples of critical phenomena characterized by scaling properties different from their equilibrium counterparts. Loosely speaking, a DPT is associated with the emergence of well distinct temporal evolutions of certain observables following a quantum quench, with the control parameter of the transition being the amplitude of the quench. Theoretically, DPTs have been especially described in fully connected spin models and in $\phi 4$ field theories with O(N) symmetry in the large N limit [1]. On the experimental side, observations and characterizations of DPTs have been achieved with cold atoms, and recently our team has unveiled the existence of a DPT for light in time-varying nonlinear media [2].

During this internship, we propose to investigate DPTs from a novel perspective, namely the dynamics of entanglement across the transition point. This analysis is motivated by the recently shown generation of robust squeezed states in the vicinity of phase transitions, and from the general importance of understanding and controlling entanglement in many-body systems, at both the fundamental and practical levels. The aim of the internship is to address this question in the framework of the dynamical O(N) model in the large N limit, a paradigmatic system displaying a DPT that can be partially captured analytically.

The project will be conducted at Laboratoire Kastler Brossel in Sorbonne Université, within the "Quantum Theory, Atoms and Fields" group. It will involve both theoretical and numerical methods.

[1] J. Marino et al., Rep. Prog. Phys. 85 116001 (2022).
[2] N. Cherroret, arXiv 2306.15409 (2023).

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