# INTERNSHIP PROPOSAL

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Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ANR PEPR

**Universal dynamic scaling in non-equilibrium quantum gases**

Understanding the mechanisms at play when a quantum system is driven out of equilibrium is a central challenge in modern science, lying at the intersection of quantum and statistical physics. Today, this problem can be advantageously studied in cold-atomic systems, where the high level of control makes fundamental concepts of non-equilibrium quantum physics accessible to experimental investigation.

In this context, a particularly interesting question concerns systems quenched across an equilibrium phase transition. In such a protocol, the correlation functions of the post-quench dynamics exhibit remarkable time-dependent scaling laws and dynamic exponents, whose values and universal properties are not fully understood. In a recent experiment involving 3D bosons quenched across the BEC transition [1], such dynamic scaling was measured in the form of an inverse particle cascade in the momentum distribution of the Bose gas. While the theory of weak wave turbulence provides partial insight into these findings [2], the exact value of dynamic exponents has not yet been quantitatively explained, likely due to the non-perturbative nature of non-equilibrium evolution.

The aim of this M2 internship is to analytically derive and solve a quantum kinetic equation describing quantum quenches in a Bose gas across the BEC transition, focusing on the non-perturbative regime where the gas's strongly correlated nature cannot be ignored. The first step will involve deriving this kinetic equation using a Keldysh field-theoretic formalism. Subsequently, the quantum kinetic equation will be solved numerically to investigate the phenomenon of universal dynamic scaling. This internship offers an excellent opportunity to delve into the modern research fields of non-equilibrium quantum physics and ultracold Bose gases.

[1] J.A.P. Glidden et al., Nature Phys. 17, 457 (2021)
[2] E. Gliott, A. Rançon, N. Cherroret, arXiv 2405.15915 (Phys. Rev. Lett., in press)

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