Postdoctoral position in theoretical physics :
Dynamical phase transitions in quenched Bose gases

Location : "Quantum Theory, Atoms and Fields" group, Laboratoire Kastler Brossel (LKB), Sorbonne Université, Paris 05

Duration : 24 month minimum (ANR funding)

Starting date : January 2nd, 2025

Description : Understanding how a many-body system evolves dynamically after a quantum quench is a fundamental challenge of modern science. 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 dynamical exponents, whose universal properties and robustness remain to be established.

The main goal of this postdoc project will be to provide a theoretical description of the dynamics of 2D Bose gases quenched across the Kosterlitz-Thouless transition from their superfluid phase. In this scenario, recently considered in experiments using atomic [1] and optical [2] quantum fluids, the post-quench evolution suggests the existence of a critical quench separating two dynamical phases, characterized respectively by time-dependent algebraic and exponentially-decaying correlations, reminiscent of the equilibrium transition. The post-doctoral researcher will develop a non-equilibrium field-theoretical treatment of this phenomenon using a Keldysh approach, as employed in previous works by the team [3, 4] but here built upon a 2D Sine-Gordon model [5]. The researcher will then numerically solve the derived equations of motion. The resulting predictions could be compared to upcoming experiments planned by the quantum-optics group at LKB. Subsequently, several open problems could be addressed, such that the robustness of the dynamical phase transition in the presence of disorder [6], or on the characterization on non-stationary turbulence arising from quantum quenches across the BEC transition in 3D Bose gases [7].

The position is funded by the ANR project "FUSIoN". The theoretical methods employed will (not exclusively) involve Keldysh field theory, quantum kinetic equations and their numerical resolutions, and truncated-Wigner approaches.

Profile and skills required : A good knowledge of the physics of quantum gases and a taste for both theoretical methods of field theory and numerical simulations are required. An expertise of non-equilibrium systems would be a strong asset. The hired postdoc will be highly dynamic, creative and motivated, both able to work independently and to regularly communicate with the team.

How to apply : Interested candidates should send their application to Nicolas CHERRORET (nicolas.cherroret@lkb.upmc.fr). They must include a CV highlighting the skills required for the research project and a description of the previous research activities.

[1] S. Sunami et al, Science **382**, 443 (2023)
[2] M. Abuzarli, N. Cherroret, T. Bienaimé, Q. Glorieux, Phys. Rev. Lett. **129**, 100602 (2022)
[3] C. Duval, N. Cherroret, Phys. Rev. A **107**, 043305 (2023)
[4] C. Duval, N. Cherroret, arxiv 2405.08606 (2024)
[5] P. Heinen, A. N. Mikheev, and T. Gasenzer, Phys. Rev. A **107**, 043303 (2023)
[6] T. Scoquart, D. Delande, N. Cherroret, Phys. Rev. A (Letter) **106**, L021301 (2022)
[7] E. Gliott, A. Rançon, N. Cherroret, arxiv 2405.15915 (2024)