Laboratoire Kastler Brossel
Sorbonne Université
Départment de Physique,
4 place Jussieu, 75005 Paris
E-mail: quentin.glorieux@lkb.upmc.fr
Project URL: www.quentinglorieux.fr
Group: www.quantumoptics.fr

Postdoctoral Fellowship (2 to 4 years) on Quantum Fluids of light at LKB, Paris

JOB SUMMARY

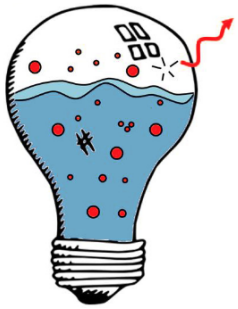
- **Job Position**: Postdoctoral Fellow
- **Research Field**: Quantum gases, quantum optics, cold atoms.
- **Employer**: Sorbonne University
- **Location**: Paris, France
- **Application deadline**: July 31st 2023
- **Salary**: 2100€ - 2850€/month net salary (depending on experience)
- **Duration**: 24 months (up to 48-60 months possible)
- **Starting date (expected)**: October 1st 2023
- **Funding**: ERC Consolidator Grant

SCIENTIFIC PROJECT

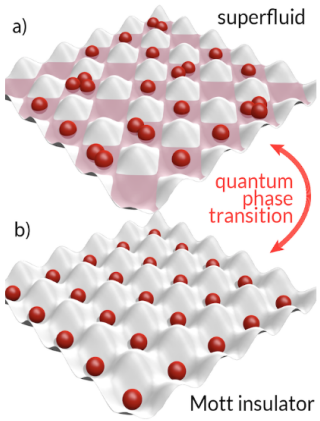
Photons are great carriers of information but they usually don't interact with one another. Atoms interact but are hard to manipulate and do not benefit from the toolbox of **quantum optics** for detecting quantum fluctuations and entanglement.
Many approaches have been proposed to marry these two systems for **quantum simulation of condensed matter with strongly interacting photons**, but to date, the realization of large-scale synthetic materials made of optical photons is still missing.

This **ERC funded project** targets this exciting goal, namely the **creation of synthetic photonic matter** and relies on the original approach of **engineering a quantum phase transition in a fluid of light**.

During this fellowship the main goal will be to demonstrate that a fluid of light undergoes the same phase transition, driven by quantum fluctuations, as quantum gases do, and that a **many-body state of light emerge from this transition**.



Specifically, we will investigate **the superfluid to Mott insulator transition for light propagating in a dense cold atomic cloud.** Photons will acquire an effective mass due to the paraxial approximation and we will engineer and tune the strong photon-photon interactions via a giant Kerr non-linearity induced by manipulating atomic coherences.



At the fundamental level, a Mott insulator state of light allows for **exploring truly quantum effects** such as the emergence of analogue of phase transition in non-equilibrium systems, the presence of quantum depletion and pre-thermal states and the entanglement dynamics in many-body systems. On the applied side, a photonic Mott insulator is **a giant source of single photons** (or any Fock state) with potentially several hundreds of lattice sites delivering tunable photon number-states in parallel. It will be a game changer for scalability issues **in photonics quantum technologies**.

Fluids of light is a formalism that combines the experimental strengths of **non-linear and quantum optics** with the **theory of ultra-cold quantum gases**. Specifically, it relies on the mathematical isomorphism between the Gross- Pitaevskii equation (GPE) which describes the evolution of the macroscopic wavefunction of an atomic gas with contact interactions, and the equation of evolution of an electric field in a non-linear medium. Several experimental configurations have been explored for fluids of light and they all rely on two ingredients: i) some sort of confinement to give rise to **an effective mass** and ii) a coupling with matter to induce a**n effective photon- photon interaction**.

In this project we consider **paraxial fluids of light propagating in a cold atomic cloud of rubidium atoms**. This geometry will allow to change the paradigm about what level of photon-photon interaction could be achieved in fluids of light.

As a postdoc you will **lead the construction of a new experimental apparatus** for observing a quantum phase transition of light with the support of highly qualified PhD students. In parallel, **you will be involved in the current activities** of the team (Bose-bose mixture, 1D quantum fluid of light, quantum turbulence...)

HOW TO APPLY

The **Quantum Fluid of Light team** is composed of 5-8 members (3-5 PhD students, 1-2 Master students, 1-2 postdocs) and has a strong expertise in Quantum Fluids of Light with **seminal papers** about superfluidity of light, shockwaves, quantum quenches, and phase transition.

We are looking for highly motivated candidate with an expertise in **cold atoms, atomic physics and/or quantum optics.** An experience in building a cold atoms setup is a plus. The offer is **for 2 years with 2-3 years extension possible** during the entire duration of the ERC Consolidator project.

Our lab (**Laboratoire Kastler Brossel, ENS, Sorbonne University**) offers first class equipments and a lively scientific environnement with weekly seminars of scientific leaders and many collaborations opportunities.

We strongly encourage women to apply and we do our best to create a secure and welcoming environnement for women in science. Our group is currently composed of 4 men and 4 women.

Please contact directly **Quentin Glorieux** with a CV at **quentin.glorieux@lkb.upmc.fr**