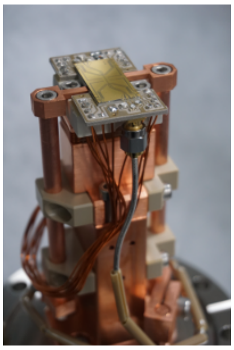
BEC group @ LPL / Paris 13 University SPC / CNRS / SIRTEQ

THESIS OFFER in ULTRA COLD ATOMS



Unidimensional gases with tunable interactions

Twenty years after the first observation of Bose-Einstein condensation, quantum gases are one of the most fascinating quantum systems now available in the lab. Far beyond atomic physics, their applications include quantum metrology, superfluidity, quantum information and quantum simulation in the wider and developing frame of quantum technology.

Specifically, ultracold gases have demonstrated their potential to be used as quantum simulators to explore complex quantum problems, thanks to a very high degree of control over their physical parameters: temperature, density, internal state... They hence serve as a benchmark to explore quantum physics to its limits. This is in particular true for low dimensional quantum systems where fluctuations play a crucial role, bringing highly–correlated configurations within experimental reach. For example one-dimensional (1D) quantum gases are being considered to simulate ladder materials, which consist of a few coupled 1D systems and might hint at the physics of high–temperature superconductivity.

In this context, the goal of the proposed project within the BEC group at Laser Physics Laboratory is to explore the properties and the dynamics of 1D Bose gases with tunable interactions. It has been shown theoretically that 1D interacting Bose gases should present two branches in their excitation spectrum, both of which exist for all atomic interaction strengths. However the second excitation branch, which elementary excitations are expected to behave as 'quantum solitons', has never been explored experimentally. This thesis project aims at the complete experimental characterization of the second excitation branch throughout the crossover between the weak and strong interactions between atoms. The 1D gas will be produced at the surface of an atom chip (see picture above). The exploration of the gas excitations will rely on Bragg spectroscopy, a well-established technique in the cold atoms community. Interactions between atoms will be tuned from weak to strong using the novel microwave–induced Feshbach resonance which we shall implement experimentally for the first time. Our experiments will rely on accurate theoretical predictions thanks to our established collaboration with a theory group in Paris.

The successful candidate will have a good background in quantum physics, and either in laser and optics or condensed matter physics. Good experimental skills in either lasers, electronics, instrumentation, data analysis or vacuum technology are valuable. He/she will participate in the various steps of the experiment, from running the experiment to the data analysis. He/she will work within the BEC group, benefitting from stimulating interaction with the larger ultra cold atom group of about fifteen people, including three other ultra cold atom experiments and a theory group. Our group is a member of SIRTEQ, a world-leading joint institute gathering all the groups in Paris area in the field of quantum technology.

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