# Continuous matter wave sources for quantum sensing

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## General context

Atomtronics is an emerging branch of physics which exploits guided atomic gases for applications to quantum technologies [1]. The experimental realization of the first continuous atomic Bose Einstein condensate has provided a new source of atomic matter waves, fundamentally different from usual atomic Bose-Einstein condensates [1]. Such matter wave sources are key for applications to quantum sensing, in particular to atomic gravimeters, which are currently limited by the lifetime of equilibrium condensates [2]. This calls for new theoretical developments to better understand the properties of these sources and improve their performance, which is the project of this thesis.

## Objectives of the thesis

We will consider models of the continuous matter wave source and theoretically investigate their properties, in particular the spatio-temporal coherence of the condensate, using both analytical methods and extensive numerical simulations. We will in particular study the influence of the geometry and of the interactions. We will then develop experimental protocols to probe coherence, and devise a proposal for an atomic gravimeter based on the continuous matter wave source.

## Requirements

The candidate is expected to have a strong background in theoretical physics and solid skills on scientific and high-performance computing.

## Bibliography :

[1] L. Amico *et al*, *Atomtronic circuits : From many-body physics to quantum technologies*, Rev. Mod. Phys. **94**, 041001 (2022)

[2] C.-C. Chen *et al*, *Continuous Bose–Einstein condensation*, Nature **606** 683 (2022)

[3] H. Zhang *et al*, *Effects related to the temperature of atoms in an atom interferometry gravimeter based on ultra-cold atoms*, Optics Express **29**, 30007 (2021)