



## **MASTER IN PHOTONICS – “PHOTONICS BCN” ERASMUS+ “EUROPHOTONICS-POESII”**

### **MASTER THESIS PROPOSAL**

**Dates: April - September 2018**

**Laboratory:** Grup d'Òptica. Departament de Física

**Institution:** Universitat Autònoma de Barcelona

**City, Country:** Bellaterra, Spain

**Title of the master thesis:** Two-component Bose Einstein condensates in coupled ring potentials

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**Keywords:** atomtronics, ultracold atoms, matter-wave transport

### **Summary of the subject (maximum 1 page):**

Ring shaped traps for ultracold atoms are one of the simplest geometries that lead to non-trivial loop circuits in the emerging field of atomtronics, which explores the use of neutral atoms to build analogues of electronic circuits and devices. For instance, Bose Einstein condensates in a ring trap have been shown to resemble the physical behaviour of superconducting quantum interference devices (SQUIDS) [1]. In addition, tunnel coupled rings have been predicted to exhibit rich physics like spontaneous angular momentum Josephson oscillations that break the initial chiral symmetry of the condensate [2], the generation of topological phases in Bose Einstein condensates in double ring structures under rotation [3], the Meissner/Vortex transition in two coupled bosonic condensates confined in a stack of two ring-shaped optical potentials [4] and complex tunnelling amplitudes for single atoms trapped in three rings in a triangular configuration [5].

In this work, we aim to study the dynamics of angular momentum states of two-component Bose Einstein condensates in tunnel coupled ring potentials to get new insight into the interplay between non-linearity, rotation and geometry. For a rotating two-component Bose Einstein condensate in a single ring, it has been recently reported that the quantization of circulation breaks down in the transition region between miscibility and phase separation [6]. Thus, it is of fundamental interest to investigate the role of the tunnelling in these systems and look for potential applications in the field of atomtronics.

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- [2] I. Lesanovsky and W. von Klitzing, Phys. Rev. Lett. **98**, 050401 (2007).
- [3] J. Brand, T. J. Haigh and U. Zülicke, Phys. Rev. A **80**, 011602(R) (2009).
- [4] T. Haug *et al.*, arXiv:1612.09109 (2016).
- [5] J. Polo, J. Mompert and V. Ahufinger, Phys. Rev. A **93**, 033613 (2016).
- [6] A. White, T. Hennessy and T. Busch, Phys. Rev. A **93**, 033601 (2016).

**Additional information :**

- \* Required skills: Basics of Quantum and Atom Optics and programming skills
- \* Miscellaneous: