

## Master in Photonics – “PHOTONICS BCN” ERASMUS+ “EUROPHOTONICS”

### MASTER THESIS PROPOSAL

**Dates: April - September 2020**

**Laboratory: Dpt. Quantum Physics and Astrophysics**

**Institution: U. Barcelona**

**City, Country: Barcelona, Spain**

**Title of the master thesis: Vortex dynamics in Bose-Hubbard rings**

**Name of the master thesis supervisor: Montserrat Guilleumas / Bruno Julia Diaz**

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**Keywords: Atomtronics, Vortex, quantum tunnelling**

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

The recent advances in the preparation and control of ultracold atomic gases have fostered the appearance of a specific subfield termed atomtronics, which is aimed at the development of technological applications based on atomic matter waves [1–3]. Its first steps are mainly pursuing successfully-applied theories from the fields of quantum optics and electronics, but also exploiting the ability of degenerate quantum gases to simulate other complex quantum systems [4].

In the current project, we would like to extend the work on tunnelling dynamics between two coupled rings, done previously in the group within the Bose-Hubbard framework [5]. In particular, the main aim would be to explore the dependence on the tunnelling dynamics and coherence of the system on the different ways of connecting the two rings. The main goal would be to find optimal configurations that would preserve coherence for longer times.

[1] L. Amico, G. Birkel, M. Boshier, and L.-C. Kwek, New J. of Phys. 19, 020201 (2017).

[2] M. K. Olsen and A. S. Bradley, Phys. Rev. A 91, 043635 (2015).

[3] B. T. Seaman, M. Krämer, D. Z. Anderson, and M. J. Holland, Phys. Rev. A 75, 023615 (2007).

[4] I. M. Georgescu, S. Ashhab, and F. Nori, Rev. Mod. Phys. 86, 153 (2014).

[5] A. Escrivà, A. Muñoz Mateo, M. Guilleumas, B. Julià-Díaz, arXiv:1908.01353

#### **Additional information:**

\* Required skills: Programming skills (python or fortran), Knowledge of quantum many-body (preferable)

\* Miscellaneous: