Lab project M2 PPN

Monday & Tuesday from Oct 2025 to March 2026

Title of the project: Control for quantum technologies

Supervisor(s): S. Guérin

Laboratory / Department / Team: ICQ/DiTeQ

Collaborations: D. Sugny / C. Latune-Lombart / C. Babin

Summary:

Quantum information technologies, such as computing, metrology and communication, require the precise control of quantum states and gates [1]. Their achievement is sensitive to noise and imperfections as currently experimented in noisy intermediate scale quantum (NISQ) computers [2]. Methods of control that realize state-transfer and quantum gates while simultaneously correcting such errors are needed. This has opened up a vast area of research in robust quantum control including adiabatic and superadiabatic techniques [3], and optimal control [4,5].

The goal of the internship consists in developing tools of robust control for various systems, such as quantum computers and atomic Bose-Einstein condensates (BEC) with possible implementation on the IBM quantum computers [6].

[1] M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum Information (Cambridge University Press, UK, 2000).

[2] J. Preskill, Quantum computing in the nisq era and beyond, Quantum 2, 79 (2018).

[3] N.V. Vitanov, A.A. Rangelov, B.W. Shore, and K. Bergmann, Stimulated Raman adiabatic passage in physics, chemistry, and beyond, Rev. Mod. Phys. 89, 015006 (2017).

[4] G. Dridi, K. Liu, S.Guérin, Optimal robust quantum control by inverse geometric optimization, Phys. Rev. Lett. 125, 250403 (2020).

[5] Q. Ansel, E. Dionis, F. Arrouas, B. Peaudecerf, S. Guérin, D. Guéry-Odelin and D. Sugny, Introduction to theoretical and experimental aspects of quantum optimal control, J. Phys. B 57, 133001 (2024).

[6] M. Harutyunyan, F. Holweck, D. Sugny, and S. Guérin, Digital optimal robust control, Phys. Rev. Lett. 131, 200801 (2023).

Type of project (theory / experiment): Theory

Required skills: Theory of quantum physics – Numerical methods