

Title: Robust Bichromatic Two-Qubit Gates Using Longitudinal Coupling

Abstract

Longitudinal spin–boson coupling offers key advantages for quantum information processing, including quantum-non-demolition interactions and reduced Purcell decay. In this project, the student will study a robust two-qubit bichromatic entangling gate that combines longitudinal coupling with dynamical decoupling to suppress qubit dephasing.

The work will focus on deriving an effective gate Hamiltonian, identifying and quantifying leading error sources (e.g., dephasing and finite bosonic-mode occupation), and validating gate performance through numerical simulations using realistic experimental parameters. If time permits, the student will explore possible implementations in semiconductor spin qubits and trapped-ion platforms. The project is theoretical and computational in nature and is designed to be feasible within a two-month undergraduate research period.

Required Skills

- Undergraduate-level quantum mechanics and computational methods
- Experience with at least one programming language

Supervisor: Iñigo Arrazola

Location: ZTF/FCT (UPV/EHU)

Supervision Plan:

The student will receive close supervision through weekly or bi-weekly meetings with the supervisor to discuss theoretical developments, simulation results, and project milestones. The project will be structured with clear milestones to ensure completion within the two-month timeframe.