# Hybrid Quantum Systems (2024)

Record number : OPR-1090

## Overview

**RESEARCH DIRECTION**

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**INFORMATION**

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**ADMINISTRATIVE UNIT(S)**

Faculté des sciences
Département de physique
Institut quantique

**LEVEL(S)**

2e cycle
3e cycle

**LOCATION(S)**

3IT - Institut interdisciplinaire d'innovation technologique
Institut Quantique Sherbrooke

## Project Description

The control of quantum information poses significant challenges, particularly given that quantum states cannot be copied. One of the consequences is the impossibility of simply converting a quantum microwave signal into an optical signal, an approach that would nevertheless solve numerous problems such as networking quantum processors.

However, light-matter interactions present a unique opportunity: these interactions are present in both the microwave and optical regimes. It is then possible to use, for example, a mechanical system that acts as an interface, allowing the transfer of quantum states from one mode to another. This type of system is extremely rich in terms of physics since it combines superconducting circuits, optics, and micromechanical systems, thereby opening up even more opportunities for the creation of new technologies, as well as for the study of fascinating physical effects such as the creation of massive quantum states.

In the group, we are actively working on the development of hybrid quantum systems including superconducting circuits, mechanical systems, and quantum dots to study and utilize light-matter interactions in the microwave regime. We use mechanical systems such as membranes, cantilevers, as well as resonators held in levitation using Paul traps. To support this research, we also fabricate our own superconducting resonators and superconducting qubits.

In terms of projects, the group's work involves various applications such as transduction between microwave and optical signals, the development of inertial sensors for aerospace, and more fundamental studies on quantum effects in massive systems. In this context, we are looking for motivated master's and PhD students. We have opportunities in the development of an optical-mechanical interface for transduction, the development of inertial sensors, and in levitated systems.

The group's research projects are part of various collaborations. Notably, we are a member of a consortium of six Canadian universities focused on the development of quantum information processing systems. We have close ties with entrepreneurship through a company emerging from the group that is currently being established. Some projects will be in direct collaboration with this company.

The group's experimental work is carried out within the Quantum FabLab in the new building of the Institut Quantique (IQ) at Université de Sherbrooke. The systems used are mostly very low-temperature systems (10 mK). We also have a laboratory space dedicated to the group

for device preparation. For projects involving fabrication, we also have access to the clean rooms in the Department of Physics and regularly use the facilities at 3iT.

## Discipline(s) by sector

### Sciences naturelles et génie

Génie physique, Physique

## Funding offered

To be discussed

The last update was on 13 August 2024. The University reserves the right to modify its projects without notice.