

## Proposition d'un Projet de Recherche en Laboratoire

**Titre** : Photon-photon interactions in semiconductor microcavities: a numerical study

**Laboratoire d'accueil** : Centre de Nanosciences et de Nanotechnologies (C2N), CNRS, Université Paris-Saclay, 10 Boulevard Thomas Gobert, 91120 Palaiseau, France

**Résumé** : Optical photons, the particles representing a quantum of light, are well known not to interact in vacuum. When injecting photons into a nonlinear optical material, one can make them interact together: this is the realm of nonlinear optics. At C2N, we are working on nonlinear optical materials made of semiconductor microcavities, where we aim to engineer photon-photon interactions that are significant at the quantum (single photon) level. With this goal in mind, we have recently designed an experiment to precisely measure the value of the interaction constant. At the theoretical level, the (open) system is well described by a Lindblad master equation, which can be solved numerically using different methods.

In this project, we propose a theoretical and numerical investigation of photon-photon interactions in semiconductor microcavities. In collaboration with the experimental team at C2N, the intern will implement a solver of the quantum master equation that will allow efficiently exploring the vast parameter space and guide the experiments. Remarkably, the quantum master equation can be mapped to a set of stochastic equations in the positive-P representation, which can be solved efficiently through the use of parallel computing on a computer cluster. In this PRL project, we will be interested in ways to further speed-up the calculation, in particular by using a graphical processor unit (GPU). Throughout the project, the intern will benefit from access to the C2N computer cluster, and will be co-supervised in collaboration with our theory partner at Université Paris Cité (A. Le Boité's team).

**Mots clés** : Quantum physics, Nonlinear Optics, Exciton polaritons, Quantum open systems, Quantum master equation

**Nature** : The internship will be realized in the quantum polaritonics team at C2N (<https://goss.c2n.universite-paris-saclay.fr/fr/members/sylvain-ravets/quantum-polaritonics/>), in close collaboration with the experimental team. This project will mostly focus on the numerical aspects of the physics, with a strong theoretical component. Additionally, the obtained results will be confronted to the experiments performed in parallel at C2N.

**Accueil d'un binôme possible** : Y

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