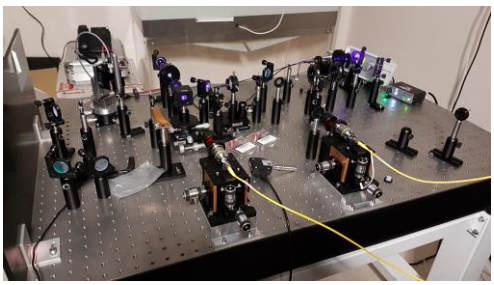
Laboratory of Physics and Modeling of Condensed Matter – Institut Néel

PhD thesis project

Quantum and nonlinear optics of disordered media

General context:
Quantum communications and quantum information processing, including the rapidly developing field of quantum reservoir computing, often rely on optical qubits as information carriers. In this context, the robustness of the physical processes against decoherence induced by disordered media is of major importance at any steps: the photon production, propagation, processing, etc. especially in view of maintaining the quantum correlation properties of entangled photons. From a wider point of view, multiple light scattering in strongly disordered media (dense suspensions or powders of nanoparticles, clouds of cold atoms, etc.) is known to lead to numerous mesoscopic phenomena including Anderson localization, universal fluctuations of transmission (or "conductance"), long- and infinite-range correlation of scattered intensity, that strongly impact the quantum properties of light.

Subject, available means:
This project is a combined experimental and theoretical effort aimed at understanding quantum and nonlinear optical processes in the presence of disorder that induces strong multiple scattering of light. In a typical experiment, a powerful light pulse will be sent into a suspension or a powder of sub-micron-sized particles and the nonlinear signal generated by the medium (e.g., second harmonics or parametrically generated entangled photon pairs) will be measured and its quantum statistics will be studied.



Another configuration to consider is that of an entangled photon pair is transmitted through a strongly scattering nonlinear medium for analyzing the persistence of entanglement with clear applications to information transfer through foggy air. Most of experimental means are already available (pulsed laser for SHG, Signac loop for entangled photons generation as well as the detection based on four photon correlation measurements). The candidate will also have access to numerical resources (computing cluster) for finite element simulations of the light-matter interaction at the single particle level while large ensembles and multiple scattering will be treated with a combination of analytic diagrammatic theories and numerical simulations to provide a statistical characterisation of the nonlinear processes.

Formation / Competences:
The successful candidate is expected to have (or to earn soon) a Master or equivalent degree in physics and to be interested in both theoretical and experimental aspects of quantum optics research. He or she will apply for a PhD scholarship to work under joint supervision of Sergey Skipetrov and Guillaume Bachelier at the Laboratory of Physics and Modelling of Condensed Matter and Neel Institute in Grenoble, France.

Contact:
Interested candidates should send a CV and a short letter of motivation to sergey.skipetrov@lpmmc.cnrs.fr and guillaume.bachelier@neel.cnrs.fr as soon as possible but not later than **March 25, 2021**.