Light-matter interaction at the single photon level: fundamentals and potential for quantum information

The general goal of the quantum optics theory group at Néel Institute is to explore light-matter interaction at the single photon level, with a special focus on solid-state devices. Depending on her/his personal taste, the candidate will join one of the subjects currently explored in the group:

1. **One-dimensional atoms.** By definition, 1D atoms interact with photons propagating in a single direction, like quantum dots in photonic wires, or qubits in transmission lines. Tight focusing of the light allows to enter the regime where a single photon can be absorbed by a single atom, or, if the atom is initially inverted, efficiently stimulate the emission of another photon (arXiv:1107.0263). By quantizing the light field, we plan to explore the potential of these devices for quantum information, e.g. single photon amplification or photonic gates.

2. **New regimes for cavity quantum electrodynamics.** Here with revisit with artificial atoms the results of quantum optics well established in atomic physics, with the aim to exploit the peculiarities of the solid state to develop innovative devices for nanophotonics. In particular, an artificial atom is embedded in a matrix, hence undergoes intrinsic decoherence which broadens its emission line. Thus, when they are coupled to high quality factor cavities, artificial atoms can be seen as emitters of white single photons, which opens new regimes for CQED. In this framework, decoherence appears as a resource allowing to develop new types of single photon sources (PRA79, 053838) and nanolasers (PRB81, 245419). Building on recent results (NJP 13, 093020), a perspective is to increase the number of emitters one by one, with the aim to bridge the gap between quantum and classical sources of light.

Work is performed in close collaboration with the experimentalists of the group and within an international network (UFMG, Brazil, Pavia University, Italy and CQT, Singapore). The candidate should have robust basis in quantum optics; skills in numerical computing will be appreciated.