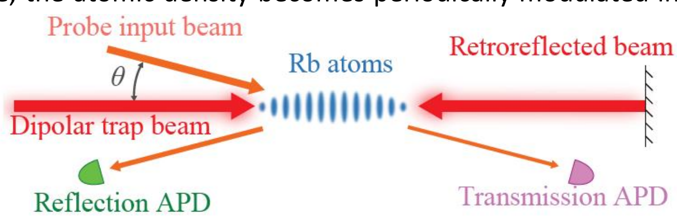
PhD or Postdoc position

Spontaneous emission and quantum memory within a 1D atomic lattice

Institut de Physique de Nice, Nice (France)
Cold-atom group

Cold atoms coupled to photons are a promising platform for **quantum information, computation and communication**: atoms are adequate systems to store and/or correlate photons, while the photons themselves are efficient carriers of information. For example, quantum communication over great distances needs quantum repeaters to compensate attenuation in fibers, and these repeaters can be made from **quantum memories** based on cold atoms, which are the most efficient to date [1].

In this project, we want to study the properties of a novel type of quantum memory based on cold atoms. By trapping the atoms in a retroreflected stationary wave, the atomic density becomes periodically modulated in the longitudinal direction. This creates a **photonic band gap**, which can be probed by the Bragg reflection off the atomic lattice (see figure and ref. [2]). Recently, we have studied the transient dynamics of the Bragg reflection when one switches off the probe beam [3].



Now we want to study the **inhibition of the spontaneous emission** from some excited atoms in the middle of the lattice. This would be a more direct and spectacular signature of the photonic band gap.

Next, we want to exploit this system in a quantum-memory protocol and study how the band gap may improve the efficiency of the memory and create new functionalities. For that, we will implement electromagnetically-induced transparency (EIT), which is a known protocol for quantum memory. In this photonic-band gap system, EIT has been used in the past to create an all-optical switch between two output ports [4]. We will extend this idea in the pulsed regime, adding a stage of storage. This would create a **quantum memory with two output ports**. We will also study how the increase of the **group velocity** due to the steep dispersion at the band edge may improve the light-atom coupling and thus the efficiency of the memory.

The subject is **mainly experimental**, although numerical simulations will be performed for comparison with the experiment. The applicant will work with a second-year PhD student already on the experiment. Collaboration with French (Paris, Toulouse, Bordeaux) and international (Brazil) partners is expected.

Applicant skills: Experiments in optics and laser physics, basic knowledge of atomic physics (PhD level); PhD on a cold-atom experiment (postdoc level).

Supervisor: William Guerin, william.guerin@univ-cotedazur.fr

Références:

[1] M. Caro, F. Hoffet, S. Qiu, A. Sheret, J. Laurat, Optica **7**, 1440 (2020).
[2] A. Schilke,C. Zimmerman, P. Courteille, W. Guerin, Phys. Rev. Lett. **106**, 223903 (2011).
[3] S. Asselie, J.-M. Nazon, R. Caldani, C. Roux-Spitz, W. Guerin, in preparation.
[4] A. Schilke,C. Zimmerman, W. Guerin, Phys. Rev. A **86**, 023809 (2012).