Master 2 thesis & PhD proposal

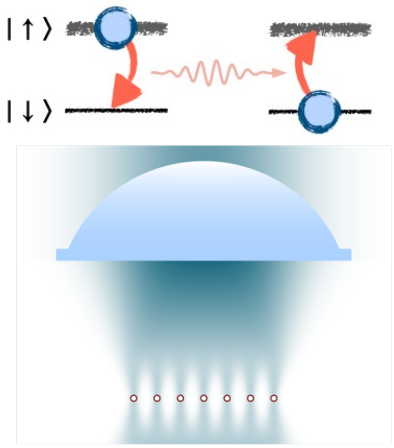
Dissipative quantum simulation with sub-wavelength atom arrays

Quantum Optics – Atoms group (https://atom-tweezers-io.org)
Laboratoire Charles Fabry, Institut d'Optique, Palaiseau, France

Proposal for a Master 2 thesis to be followed by a PhD (**starting date: spring 2020**).

Supervisors: Antoine Browaeys: antoine.browaeys@institutoptique.fr
Igor Ferrier-Barbut: igor.ferrier-barbut@institutoptique.fr
Internship allowance: **Yes**

The goal of this project is to develop a **quantum simulator for dissipative quantum-many problems**, to emulate many-body ensembles with intrinsic collective dissipation and with external driving by a classical or quantum field. The platform will be based on fully configurable arrays of atoms with interparticle distance of a few hundred nanometers, *i.e.* much smaller than an optical wavelength.



The structuring of atomic arrays in optical tweezers creating a configurable quantum simulator has been invented by our group [**1,2**]. The interaction will be here the resonant dipole interaction that exists between atoms driven by resonant light, which exhibits both a real (conservative) and imaginary (dissipative) part. The exchange of excitation that results from the interaction naturally implements an interacting spin system where the two atomic states are mapped onto the two states of a spin-1⁄2. This system is thus a quantum simulator for dissipative spin systems. To reach strong interactions, the interparticle distance must be shorter than the wavelength of the transition between the two levels, here at 780nm for Rb atoms.

This internship will take place on an existing cold rubidium setup, with high-numerical-aperture lenses in vacuum, with which we recently demonstrated enhanced collective light scattering in an atomic chain with micrometer interatomic spacing [**3**]. The **topic of the internship** will be to develop the holography tools based on the expertise of the group to create configurable arrays and then to compress them to much shorter interatomic distances, and to perform the first experiments dressing the atoms with light following our recent theoretical proposal [**4**].

This Master 2 internship will be followed by a PhD on the same thematic in our group.

References:

[1] D. Barredo *et al.*, Science **354**, 1021 (2016).
[2] D. Barredo *et al.*, Nature **561**, 79 (2018).
[3] A. Glicenstein et al., *Phy. Rev. Lett.* **124**, 253602 (2020).
[4] S. Masson et al., arXiv: 2008.08139 (2020).