Master 2 thesis & PhD proposal

Dissipative quantum simulation with sub-wavelength atom arrays

Quantum Optics – Atoms group (https://atom-tweezers-io.org)

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

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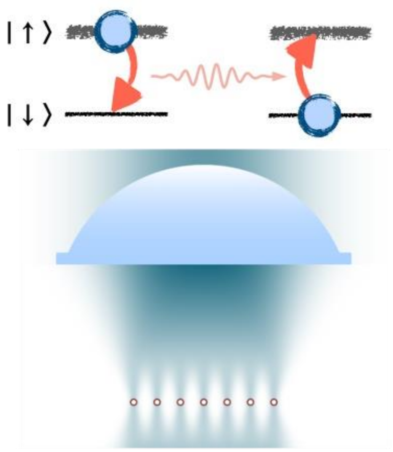
Internship allowance: **Yes**

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.

We recently demonstrated enhanced collective light scattering in an atomic chain with micrometer interatomic spacing [**3**]. To reach full control on structured arrays, our group is starting a new experiment based on a lanthanide atom: dysprosium, which features a level structure offering a rich toolbox for atom-light interaction studies. It will in particular allow to obtain sub-$\lambda/2$ spacing and probing and addressing at the single atom level. **In the internship we propose**, we will design and build a new laser system, using two transitions of Dy. This will set the basis for a fully versatile dysprosium tweezer array experiment, resting on the strong experience of the group. This Master 2 internship will be followed by a funded PhD pursuing the building of the setup and performing the first studies [**4**].

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).