Coupling atomic arrays to nanofibers: generation, storage and reflection of single photons

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In recent years, the coupling of one-dimensional waveguides and atoms, either real or artificial, has raised a large interest. Beyond the remarkable ability to couple a single emitter to a guided mode, this approach would also enable all-fibered quantum memories and interfaces and the engineering of photon-mediated long-range interactions between multiple qubits. This emerging field of waveguide quantum electrodynamics promises unique applications to quantum networks, quantum nonlinear optics, and quantum simulation.

In this talk, I will present our ongoing efforts based on 1D chains of cold atoms trapped near a subwavelength-diameter optical fiber. I will focus on this implementation and describe our recent observations of collective effects: the demonstration of EIT optical storage in this all-fibered setting [1], the heralding of a single collective excitation and its subsequent conversion in a guided single photon, and the observation of a large Bragg reflection up to 75% for the guided light [2]. While the first two experiments rely on the overall optical depth of the medium, the third one results from long-range order of the atoms. In each experiment, only 2000 atoms were sufficient due to tight transverse confinement. These observations demonstrate key ingredients for the exploration of a variety of emerging and potentially rich protocols based on 1D reservoirs coupled to atoms.

[1] B. Gouraud *et al.*, Demonstration of a memory for tightly guided light in an optical nanofiber, Phys. Rev. Lett. 114, 180503 (2015).

[2] N.V. Corzo *et al.*, Large Bragg reflection from one-dimensional chains of trapped atoms near a nanoscale waveguide, Phys. Rev. Lett. 117, 133603 (2016).