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POS-2 - Loading laser-cooled atoms into a cavity formed by a hollow-core fiber capped with a pair of dielectric metasurfaces

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Hollow-core photonic-crystal fibers (HCPCF) provide avenues to study light-matter interactions under tight transverse confinement of both atoms and photons. We implement a novel type of cavity by attaching a pair of photonic crystal (PC) slabs acting as high reflectivity dielectric metasurface mirrors onto the ends of a piece of a HCPCF. These mirrors, which can reflect perpendicularly incident light, consist of a dielectric membrane with sub-micrometer thickness and periodically arranged holes with diameter and spacing of approximately 700nm. The cavity further enhances the atom-photon interactions by longitudinally confining light in the fiber. Introduction of laser-cooled atoms into the fiber core through the holes of the PC mirrors should be possible when a red detuned laser, diverging from the fiber, guides the free falling atoms from a magneto-optical trap (MOT) toward the fiber tip using optical dipole forces.

We present calculations for the loading efficiency of atoms into our fiber-integrated cavities, considering perturbations to the dipole potential due to the presence of the PC membranes, as well as atom-dielectric interactions. An overall potential landscape is obtained through simulations, leading to statistical simulations of atom-trajectories from which the loading efficiencies can be found. We discuss the potential uses of the resulting fiber-integrated cavity loaded with laser-cooled atoms for applications such as single-photon all-optical transistors and superradiant lasers.

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