Tapered Optical Nano-fibres as Detectors for Atoms Trapped in a 1D Optical Lattice

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We investigate the possibility of using a dark optical nano-fibre to detect and resolve the distribution of atoms trapped in a one-dimensional optical lattice arranged perpendicularly to the axis of the nano-fiber (see the schematic in Fig 1). This is an alternative to the recently constructed atom microscopes and an extension to the recently suggested use of nano-fibres to locally manipulate atoms in optical lattices[1].

This scheme is very sensitive to different orientations of the atomic dipoles with maximal emission into the guided modes occurring with radial orientation [2,3]. We calculate the rate of emission into the guided modes of the fibre and show that the effectiveness of the scheme is dependent on the size of the fibre radius, the radiation wavelength, the spacing between the atoms and the perpendicular distance between the fibre and the row of atoms. We fully consider the van der Waals force when the fibre is brought very close to the atomic array.

Among the possible applications of such a scheme is the reading out of edge states for the realization of topological quantum states in cold-atom lattice systems, which offers an opportunity for exploring topological phases. It can also be used for measuring fidelity and detecting imperfections in Mott Insulator configurations or non-destructively detecting the presence of a single atom in an optical trap .

References:

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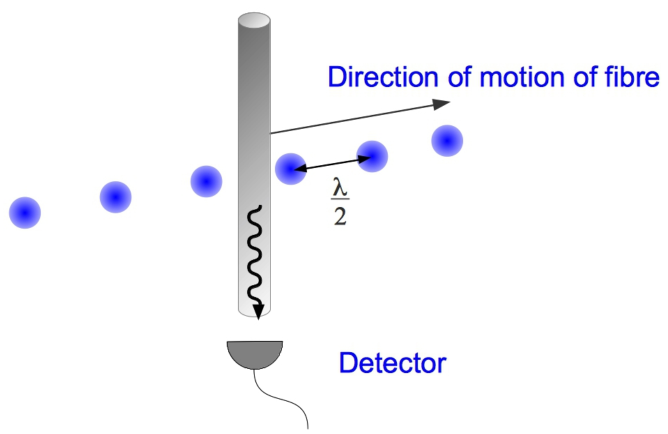

Fig 1.