Nanostructured alkali-metal vapor cells

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Atom-light interactions in micro- and nano-scale systems have received significant interest in recent years, and hold great promise for alternative technologies based on integrated emitters and optical modes. In this project, we manufacture bespoke alkali-metal vapor cells with internal dimensions down to ∼400 nm, and with internal nano-structuring of near-arbitrary atomic confinement geometries [1]. In the past, such nano-cells have been used to study the interaction between atoms and cell walls [2], as well as collective effects [3]. We combine our cells with microscopy and spectroscopy techniques to study the behaviour of atoms subject to nano-scale confinement. The ability to isolate a thermal vapor to such short lengthscales could open doors towards spatially-selective sensing, as well as the ability to reach the regime of probing low atom numbers. Our platform is robust and customizable, and could be expanded to incorporate further optical elements towards the production of scalable atom-based devices.

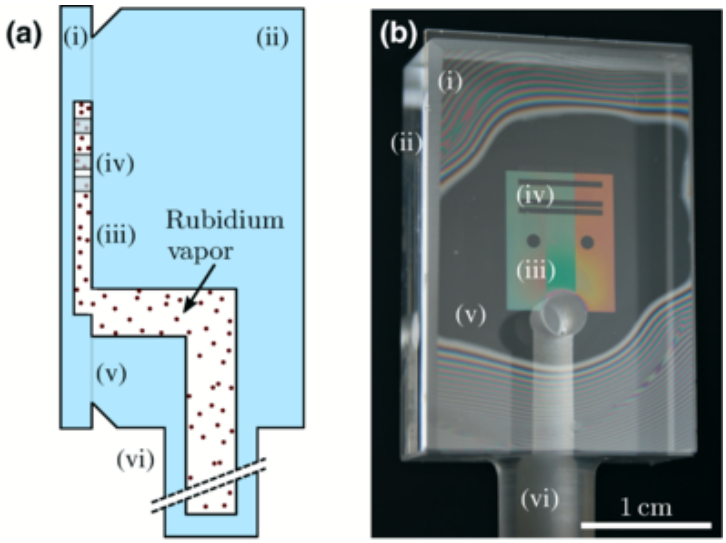

Figure 1. (a) Side cross-section schematic (not to scale) and **(b)** front-facing photograph of the nano-cell. A glass block (ii) and an etched glass slide (i) are optically contacted (v) to form the nano-regions, which are located at (iii), with nano-channels at (iv). A rubidium reservoir is attached below (vi).

[1] T. F. Cutler *et al.*, Nanostructured Alkali-Metal Vapor Cells, Phys. Rev. Appl., **14**, 034054 (2020).
[2] K. A. Whittaker *et al.*, Spectroscopic detection of atom-surface interactions in an atomic-vapor layer with nanoscale thickness, Phys. Rev. A, **92**, 052706 (2015).
[3] J. Keaveney *et al.*, Cooperative Lamb Shift in an Atomic Vapor Layer of Nanometer Thickness, Phys. Rev. Lett., **108**, 173601 (2012).