Imaging Rb-Wall Interactions and Microwave Fields in Vapor Cells

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Time-domain measurements and absorption imaging techniques are well-established in use with cold atoms, providing single-atom sensitivity and micrometer spatial resolution. The use of these powerful techniques is relatively unexplored in vapor cells, however. We have recently applied these techniques to characterise a microfabricated vapor cell, obtaining images of the T_1 and T_2 relaxation times, as well as polarisation-resolved images of the applied microwave magnetic field[1].

These techniques also enable studies of Rb interactions with cell walls, which we present here[1]. Rb-wall collisions have previously been studied using evanescent-wave techniques[2], or by looking at their effect on the bulk properties of the cell.

Fig. 1 shows images of the optical pumping efficiency (u_0) in a cell, obtained by comparing the optical depth with and without applying optical pumping. Depolarising collisions between Rb atoms and the cell walls result in reduced pumping efficiency near the cell edges. We can fit this drop-off in u_0 to give ε, the depolarisation probability of Rb-wall collisions. Our results for Rb interactions with silicon cell walls suggest a surprisingly low value of $\varepsilon = 0.05$, meaning Rb atoms can undergo as many as 20 collisions with a silicon cell wall before depolarisation. Our technique holds promise for spatially-resolved characterisation of wall coatings, and for further investigation of Rb-wall interactions.

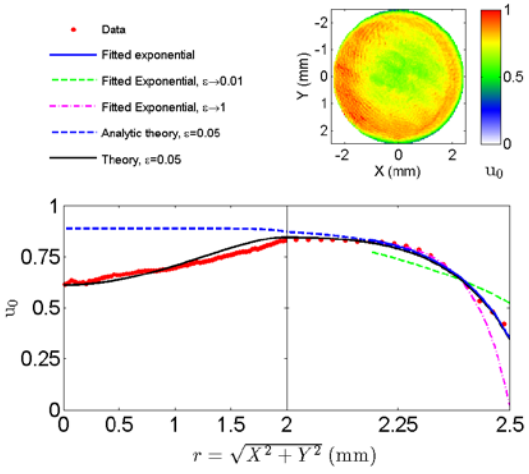

Fig. 1: Image and radial profile of optical pumping efficiency, u_0, in a 2 mm thick, 5 mm diameter Rb vapor cell. The central dip in u_0 is due to a semi-transparent deposit of Rb on the cell window. Fitting the radial profile near the cell edge gives ε, the depolarisation probability of Rb-wall collisions.

We also present the latest developments in microwave magnetic field imaging in our lab. We use an ultra-thin 6 x 6 x 0.1 mm Rb vapor cell, attached to a buffer-gas filling station, with typically 60-80 mbar of Kr buffer gas. The cell has external walls as thin as 150 µm, allowing us to approach test structures for high-resolution near-field imaging.

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