Towards atoms in a fibre

Modulating, multiplexing and memorising photons for quantum networks and computing

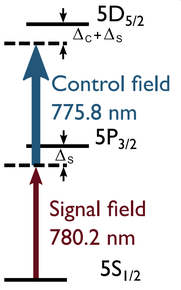
W. O. C. Davis[1], P. M. Burdekin[2], K. Harrington[1], S. E. Thomas[2], G. Booton[1], T. Waasawo[1], K. R. Rusimova[1], T. A. Birks[1], J. Nunn[1,3], P. J. Mosley[1] and Cameron McGarry[1,4,5]

[1] Centre for Photonics and Photonic Materials, University of Bath, Bath, UK, BA2 7AY
[2] QOLS, Department of Physics, Imperial College London, London, SW7 2BW, UK
[3] ORCA Computing Ltd. 30 Eastbourne Terrace, London W2 6LA UK
[4] ARC Centre of Excellence for Engineered Quantum Systems, University of Sydney, NSW 2006, Australia
[5] Present address: School of Physics, University of Sydney, NSW 2006, Australia
cameron.mcgarry@sydney.edu.au

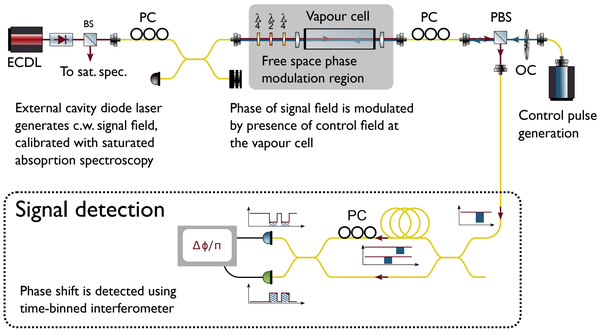
We demonstrate all optical phase modulation mediated by a two-photon transition in warm atomic vapour, alongside a fibre-integrated vapour cell with low-loss interconnects.

Phase modulation

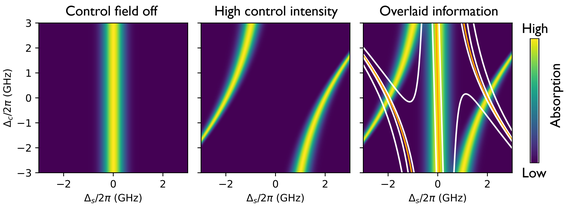
- A weak signal field counter-propagates with a strong control pulse through a rubidium vapour cell.
- The presence of the control pulse induces a change in susceptibility, resulting in a change to the phase of the signal.



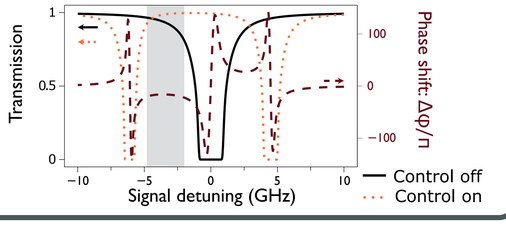
Applications:
- Fibre-integrated photonic quantum memories
- High speed (limited by control field modulation) and low-loss switching for heralded single photon sources
- Fast and efficient phase modulation of bright light



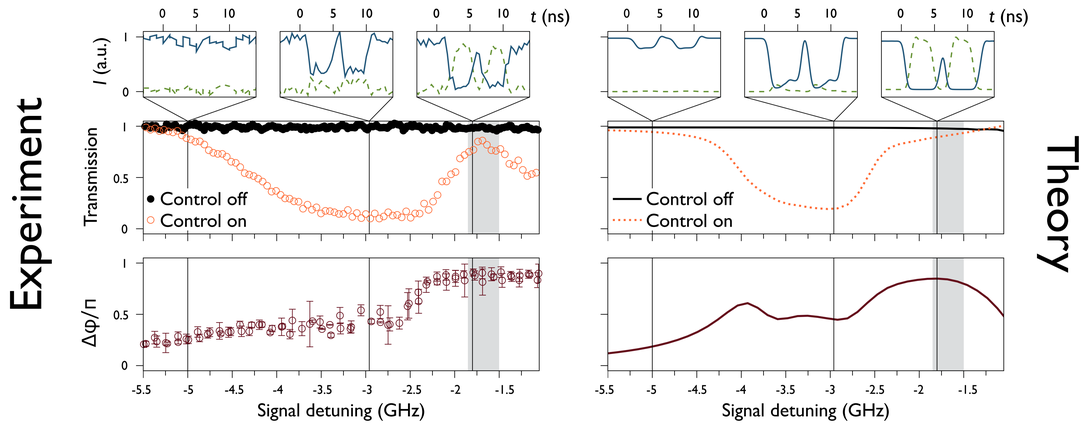
We model transmission and phase shift by solving the Maxwell-Bloch equations of motion.



Regions with high phase shift (shown by contours) and low absorption (shown in colour) are suitable for the scheme. For example, below in the shaded region with Δ_c = -1.6 GHz



High phase shift with low loss: Δφ/π = 0.90(5); T = 83(2)%



Fibre integration

- We have fabricated a cell for realising phase modulation and memories within optical fibre.
- Low-loss interconnects to hollow core fibre (HCF) are achieved by lensing in graded index fibre (GIF) into custom-designed HCF.

Low insertion loss: 0.6(2) dB at 780nm