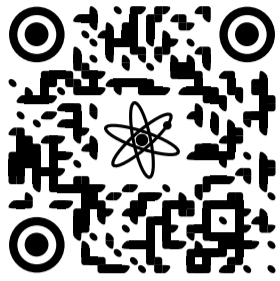


Towards fibre-integrated optical switching

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T.A. Birks, J. Nunn, P.J. Mosley

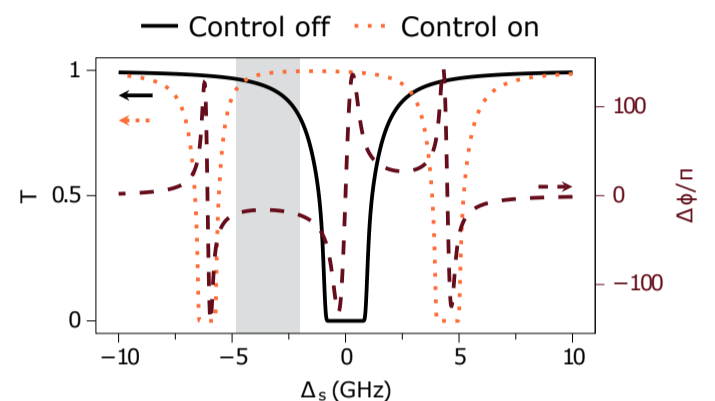
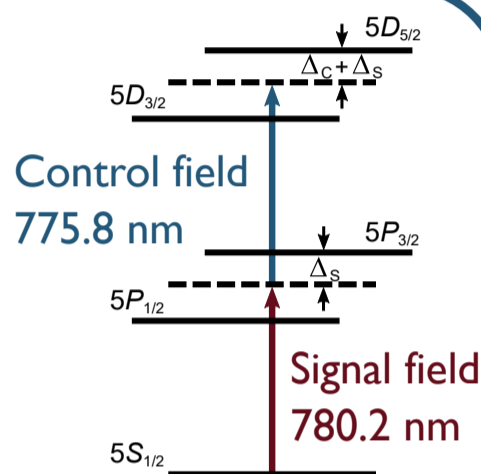
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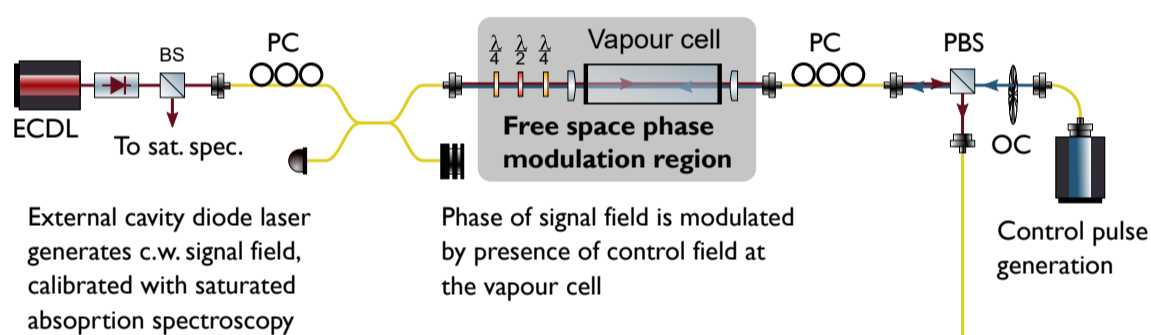
We demonstrate fast, low-loss and all optical phase shifting mediated by a two-photon transition in warm atomic vapour. We present a route towards integration with optical fibre systems.

1. 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 [1].

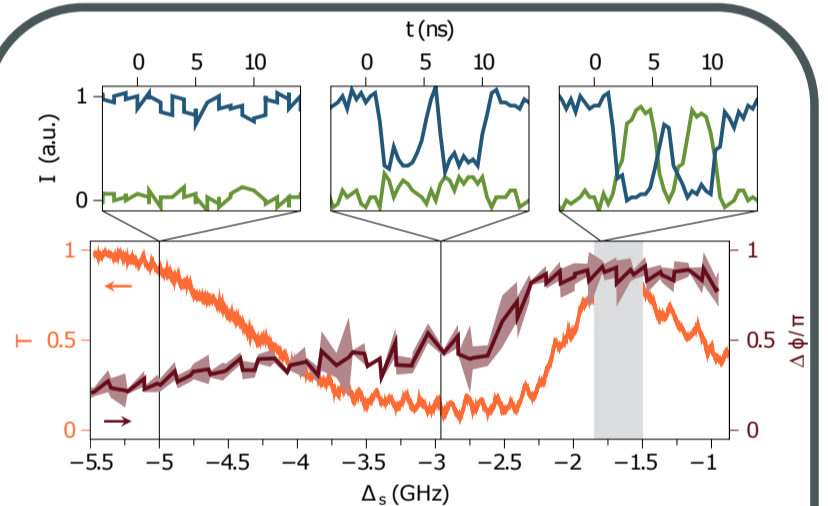
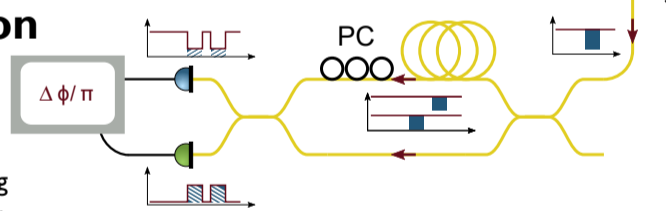


We model phase shift by solving the Maxwell-Bloch equations of motion [2].



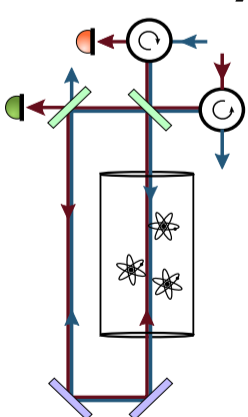
Signal detection

Phase shift is detected using time-binned interferometer

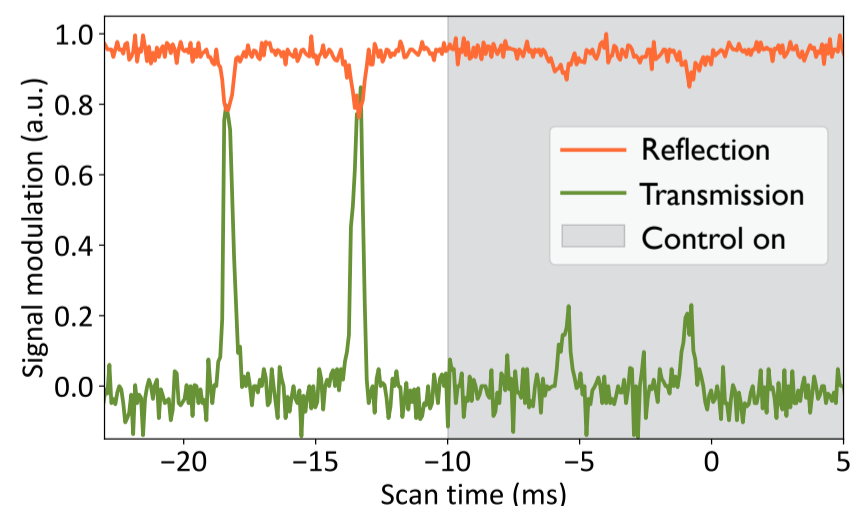


High phase shift with low loss:
 $\Delta\phi/\pi = 0.90 \pm 0.05$; $T = 74 \pm 2\%$

2. Cavity enhancement

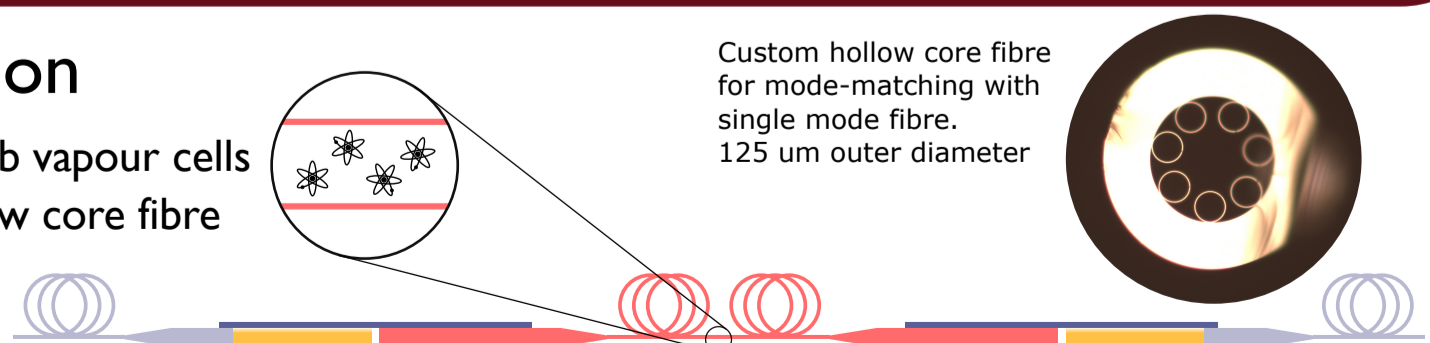


- * Enhancement is product of signal and control field finesses.
- * A bulk cavity is used currently but a microcavity is desirable for high finesse and scalability.
- * Towards photon-photon interaction and implementing gates.



3. Fibre integration

To realise fibre-integrated Rb vapour cells we are connectorising hollow core fibre to single mode fibre [3] and filling the core.



Custom hollow core fibre for mode-matching with single mode fibre.
125 um outer diameter

[1] O. Lahad and O. Firstenberg, "Induced Cavities for Photonic Quantum Gates," Phys. Rev. Lett., vol. 119, p. 113601, Sep. 2017.

[2] H. Metcalf and P. van der Straten, Laser cooling and trapping, Springer 1999

[3] D. Suslov et al., "Low loss and high performance interconnection between standard single-mode fiber and antiresonant hollow-core fiber," Scientific Reports, vol. 11, Art. no. 1, Apr. 2021.