Delay of squeezing and entanglement with EIT

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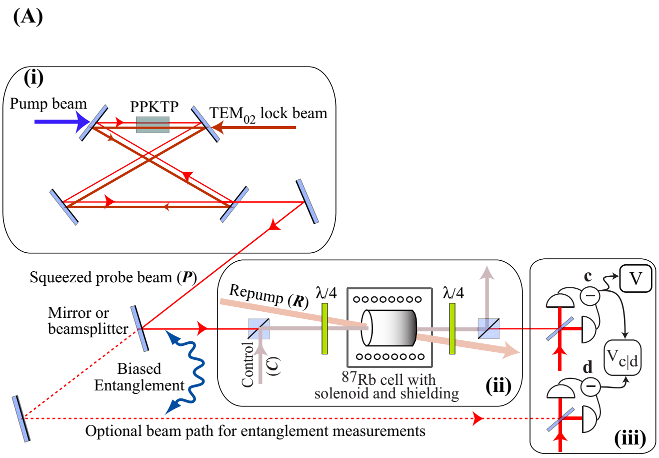
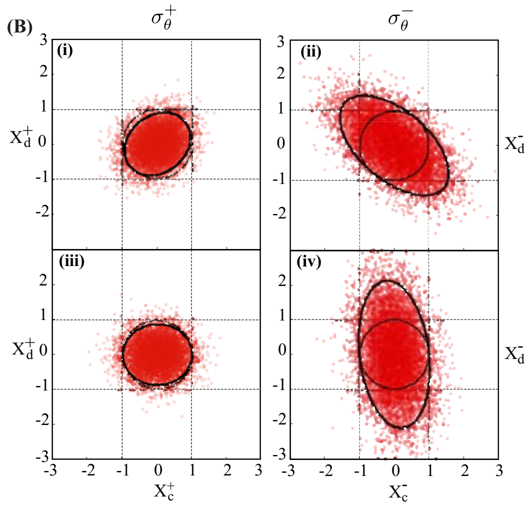
Electromagnetically induced transparency has frequently been suggested as a form of coherent optical memory [1]. In our experiment we used a hot ^{87}Rb vapour as the EIT medium and a source of squeezed light at 795 nm to generate quantum states that can be be used to test the efficacy of EIT as a coherent delay line.

Our squeezed light source [2] was based on an optical parametric oscillator (OPO) and produced squeezed vacuum states. These were first used in direct transmission through the EIT medium to show squeezed state preservation with EIT. Starting with 3.2 dB of squeezing, we observed preservation of 2 dB at the output of the gas cell [3].

Measuring the delay experienced by the cw squeezed vacuum is very difficult as there is no time reference. In order to make this measurement we prepared a biased entangled state by splitting our squeezing into 2 beams (Fig. A). Correlation measurements could then be made between homodyne detectors c and d, as shown in Fig. A(iii). Using this technique, and measuring both the amplitude and phase quadratures at the homodyne detectors, showed that half of our biassed entangled state was delayed by 2.2 μs. Furthermore, after the EIT delay we measured the Duan wavefunction separability criterion to be 0.71$\pm$0.01. Thus we have shown delay and preservation of entanglement through EIT [3].





A: Schematic of the experiment. (i) Bow-tie PPKTP optical parametric amplifier. The squeezed beam (P) is either injected directly into the EIT setup or divided using a beam-splitter to produce a pair of biased entangled beams. (ii) The gas cell used for EIT. (iii) Joint measurements are performed using two homodyne detectors to analyse the quadrature amplitude correlations. B: Correlation measurements. (i) and (ii): Scatter plots of the amplitude and phase quadratures respectively as measured for the beams c and d. The lasers were not resonant and there is no EIT. (iii) and (iv): Data as above but with EIT switched on. The solid black curves show the conditional deviation $\sigma_\theta^\pm$ calculated from the data. The dashed circles show the QNL conditional deviation obtained by blocking the two entangled paths. The coordinates of the red data points have been scaled down by a factor of two for clarity.

References

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