Information delay via electromagnetically induced transparency

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Quantum memory is an essential component for quantum computation. Electromagnetically induced transparency (EIT) [1] has been proposed as a possible scheme for achieving quantum memory via the manipulation of dark-state polaritons [2]. Experiments on the slowing of optical pulses through an atomic medium via EIT have been reported [3]. There have also been many experiments studying the storage of optical pulses in atomic vapour cells as well as in laser-cooled and trapped atoms [4]. However, recently there have been alternative interpretations on the storage of information via EIT [5].

Our aim is to study the possibility of using EIT to store quantum information. We approach this problem by considering the slowing of information in the form of modulation sidebands on an optical beam. We demonstrate a quantum noise limited delay (∼ c/10 000) of the conjugate pair of amplitude and phase quadratures of a continuous wave optical beam via EIT in a Rubidium vapour cell. Cross-quadrature coupling between the amplitude and phase quadratures have also been studied and was shown to be insignificant.

The periodic feature shows the presence of a laser locking modulation in the laser spectrum. Right figure: Phase quadrature spectral results for the photocurrent subtraction between the output probe beam after EIT and the input probe beam with a cable delay (equal to that of the EIT delay). The input probe beam was modulated with broadband noise. (i) Subtraction with EIT present and gain G1 for the delayed input probe beam signal. (ii) Subtraction without EIT. The loss due to EIT was simulated optically using a variable beam-splitter. The gain G1 for the delayed input probe beam signal was maintained but the cable delay removed. (iii) Quantum noise limit for the system, taking into account gain G1. Similar results for the amplitude quadrature were obtained.

References