Light Storage in Diamond via Stimulated Brillouin Scattering

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Linear optical quantum computing uses single photons as its primary way of transporting information, however, problems with the non-deterministic nature of logic operations and production of single photons results has led to proposals for temporarily storing photons in order to scale linear optical quantum computing to a useful level. This capability is provided by quantum memories, devices able to store and retrieve quantum information on demand, but the search for a solid state device with a broad acceptance bandwidth, wavelength tunablilty, along with low noise and high efficiency is incomplete. Here we propose the use of Brillouin scattering in diamond as a potential storage mechanism, and as a solution to these problems.

Quantum memories that employ Raman scattering, have already been demonstrated in diamond and alkali vapours. The lifetime of optical phonons in diamond are on the order of picoseconds [1], which makes them far too short for any practical applications. Light storage via Brillouin scattering has already been demonstrated in materials such as silica and chalcogenide [2], lifetimes for these processes are limited to just a few nanoseconds. It is thought that due to diamonds high stiffness (and therefore high thermal conductivity), the lifetime of acoustic phonons in this material will be relatively high [3].

Presented is a series of experiments with the goal of using Brillouin scattering in diamond as a quantum memory device, the first of which regards measuring the lifetime of acoustic phonons in diamond as a means to test the viability of the memory.

[1] D. G. England *et al.*, “Storage and Retrieval of THz-Bandwidth Single Photons Using a Room-Temperature Diamond Quantum Memory,”
[2] M. Merklein, *et al.*, “Brillouin-based light storage and delay techniques,” 2018.
[3] R. Tabrizian, *et al.*, “Effect of phonon interactions on limiting the f.Q product of micromechanical resonators,”