Improving 1 and 2-qubit gate fidelities for laser-written nitrogen vacancy centres in diamond

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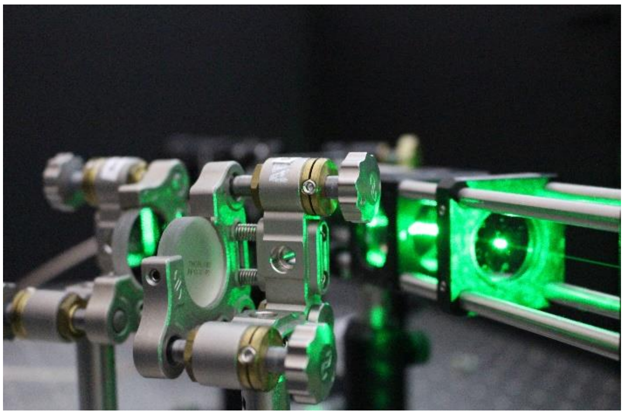

We send in green light to excite a single NVC, polarizing its electron spin, before using magnetic resonance to control its quantum state and then detecting its final state by detecting the red florescence it emits.

If a quantum computer could be built with enough qubits, it would be able to solve problems that are intractable with the classical computers we have now. A leading design for this is to build nodes with five or more interacting qubits, and then link up many of these nodes. Nitrogen vacancy centres (NVC) in diamond at cryogenic temperatures have been used to demonstrate this linking by entangling their electron spins optically. The nuclear spins coupled to NVC can have long coherence times of over 10 seconds.

This project will make use of our laser-written NVC and the laser-written electrical wires we can create around them [1, 2]. The laser writing is done by our collaborator Patrick Salter in Oxford University. We will build arrays of these qubits and use composite pulses to demonstrate high-fidelity control of both the electron spin and the coupled ^{13}C nuclear spins. Initial experiments will be at room temperature, but cryogenic measurements will be used also as this is needed to entangle two NVC.

We have also built related experiments including versions that operate with a large ensemble of NVC, which we want to commercialise as a magnetometer. We collaborate with Jason Smith's group in Oxford because they are working on speeding up the optical entanglement of two NVC as part of the Networked Quantum Information Technology (NQIT) program: the UK National Quantum Technology Hub for Quantum Computing. This PhD studentship is fully funded by the EPSRC through NQIT.

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[1] Y.-C. Chen *et al.*, Nat Photon **11**, 77 (2017).
[2] C. J. Stephen *et al.*, arXiv:1807.03643 (2018).

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