Building a node in a diamond quantum computer

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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.

In this project we will create a single node with five or more qubits using a single NVC and the $^{13}$C nuclear spins close to it. We have built most of the equipment and will soon begin testing it at a temperature of 4 K. In addition to being useful as a node in a quantum computer, we will explore how these coupled spins could be used as a sensitive nanoscale magnetometer.

We have also built related experiments including versions that operate only at room temperature, only with a large ensemble of NVC, and only with optically-levitated nanodiamonds. 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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