Towards quantum networks with group IV colour centres in diamond

UNIVERSITY OF CAMBRIDGE

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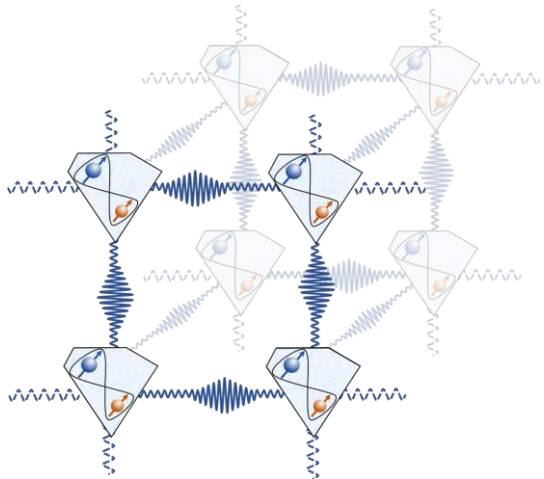
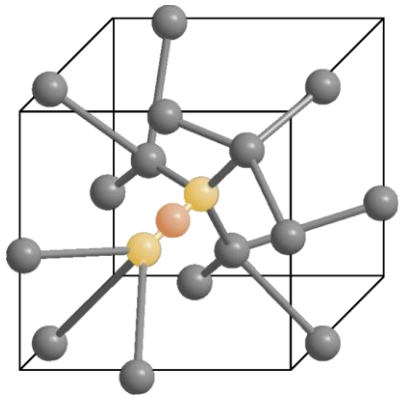
Quantum Networks

For usable quantum networks you need:

1. Good quantum bit (qubit) nodes
   - Long spin coherence time
2. Good connectivity between nodes
   - Easy entanglement via photons



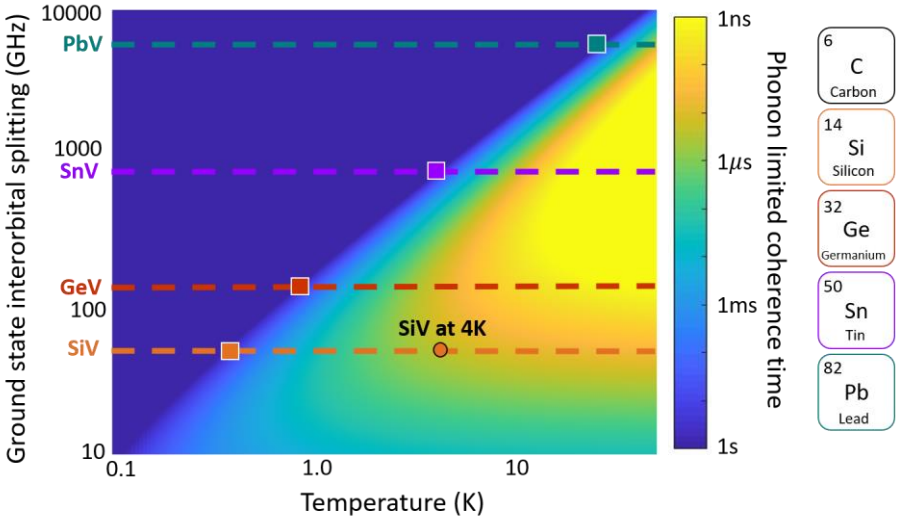


Extend phonon-limited coherence time by:

1. Reducing temperature
2. Increasing the interorbital splitting- move to heavier group IV atoms

Group IV colour centres

- A convenient way of “trapping” atoms
- High-quality photons
- Strongly coupled nucleus



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Transform Limited Tin Vacancy Spins

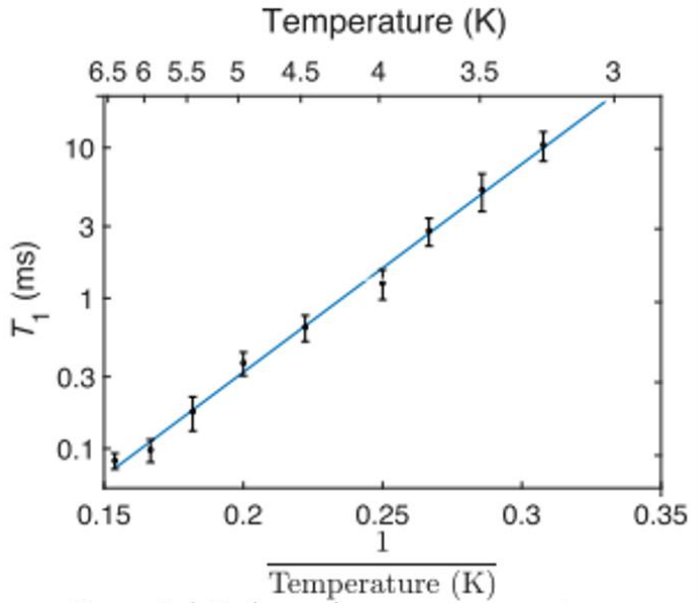

Figure 1a) *T_1 dependence on temperature showing linear dependence of log(T_1) on 1/T*

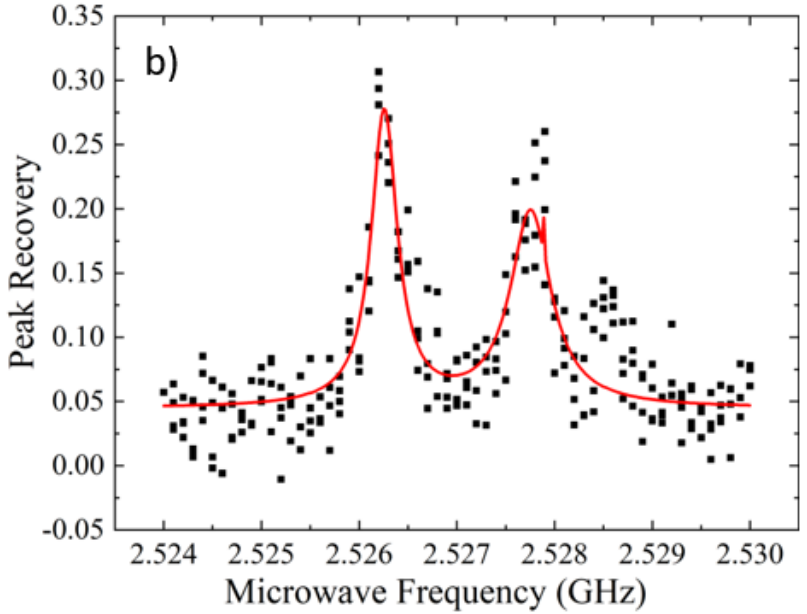

Figure 1b) an optically detected microwave resonance spectrum of SnV at 2.9 K with fitted linewidths of 293 ± 30 and 356 ± 60 kHz

- Cooling from 6 to 3.25 K gives > 2 orders of magnitude improvement in coherence times
- Cooling improves the coherence time in agreement with single phonon-mediated decay mechanism predictions

- Narrow linewidths – we are limited by the nuclear spin bath and could improve coherence times using dynamical decoupling
- Two peaks – strong coupling to nearby spin ½ nucleus (e.g. carbon-13 within the diamond lattice

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Future Works

1. Coherent control of heavier group IV colour centres – specifically tin
2. Photon –photon entanglement from group IV colour centres for cluster states
3. Spin-spin entanglement between multiple nodes towards quantum networks