Nuclear spin qubits with coherence exceeding seconds

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Nuclear spins in solids are promising qubit candidates, but their detection at the single spin level is challenging. We use an Er^{3+} electron spin in a $CaWO_4$ crystal as an ancilla for the readout of proximal ^{183}W nuclear spin qubits [1]. The electron spin is itself measured by magnetic coupling to a superconducting resonator, whose output is directed towards a microwave photon counting at 10mK [2]. We measure nuclear spin coherence times as long as 4s [3]. Single- and two-qubit gates are performed using stimulated Raman transitions at microwave frequencies, mediated by the Er^{3+} spin excited state [3]. These results represent a step towards a new quantum computing architecture based on nuclear spin qubits interfaced by superconducting resonators.

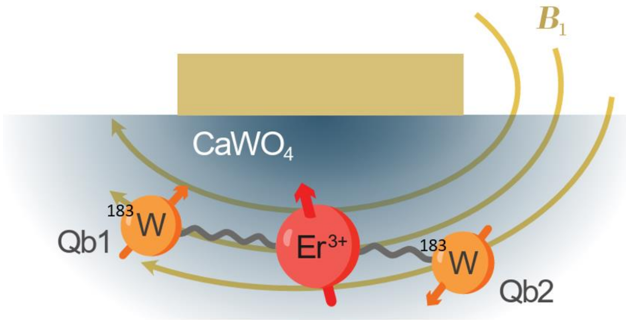

Figure 1: An Er^{3+} electron spin in a $CaWO_4$ crystal is used as ancilla to readout and entangle ^{183}W nuclear spins. The electron spin is itself measured by magnetic coupling to a superconducting resonator (gold rectangle), whose output is sent to a microwave photon counter [3].

References

[1] J. Travesedo et al., arxiv.2408.14282
[2] Z. Wang et al., Nature 619, 276 (2023)
[3] J. O'Sullivan et al., arXiv:2410.10432