Single Rare-Earth Ions in Solid State Hosts: a Platform for Quantum Networks

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Optically-addressable spins in solids are an area of intense research interest in quantum information science with applications in quantum networks, computing and sensing.

Due to recent advances in nanophotonic cavity design and fabrication, detection and control of single rare-earth ions via their highly coherent 4f-4f optical transitions have recently been demonstrated. We focus on the 171 isotope of Yb doped into a YVO_4 crystal due to low electric and magnetic field noise sensitivity facilitated by no 1st-order DC stark shift combined with optical and spin clock transitions [1].

In this talk I will introduce this platform by characterising the optical and spin transitions; subsequently, we leverage the high fidelity control and long coherence times to explore the interaction of single ^{171}Yb ions with a small local ensemble of vanadium lattice spins. We propose using collective modes of this ensemble (single spin excitations) as a secondary quantum register, a key resource for building quantum repeaters.

References

[1] J M Kindem, A Ruskuc, J G Bartholomew, J Rochman, Y Q Huan and A Faraon, Nature **580**, 201 (2020)