Optical Polarization of Nuclear Spins via the negatively charged Tin-Vacancy Center in Diamond

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Optically interfaced solid-state spins are amongst the most promising approaches for quantum networking devices, combining a local quantum register of electronic and nearby nuclear spins with long-distance transmission of coherent optical photons [1]. Amongst the Group-IV color centers in diamond with their desirable optical properties [2], the negatively charged tin-vacancy center (SnV) is particularly interesting [3, 4]. Its large spin-orbit coupling offers strong protection against phonon dephasing even at 1.7 K and robust cyclicity of its optical transitions, allowing both single-shot readout and nuclear spin access via the optical transitions.
Recently, we showed multi-axis coherent control of the SnV spin qubit via an all-optical stimulated Raman drive between the ground and excited states [5]. Optically driven electronic spin resonance data shows a hyperfine-split double-peaked structure, indicating a strongly coupled nuclear spin (^{13}C). We utilize direct-driving of the forbidden zero-quantum and double-quantum transitions (Figure 1 (b)) [6].
Our gates consist of initialization of the electron, repeated drive of the nuclear spin flipping transition, reset of the electron via a single optical scattering event (optical spin-flip transition) and readout via the single-quantum transitions (Figure 1(a)). As a next step, we report on the progress of driving the optically accessed nucleus coherently and towards implementing quantum state transfer, storage and retrieval, paving the way for a local quantum memory [7].

References

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Figures

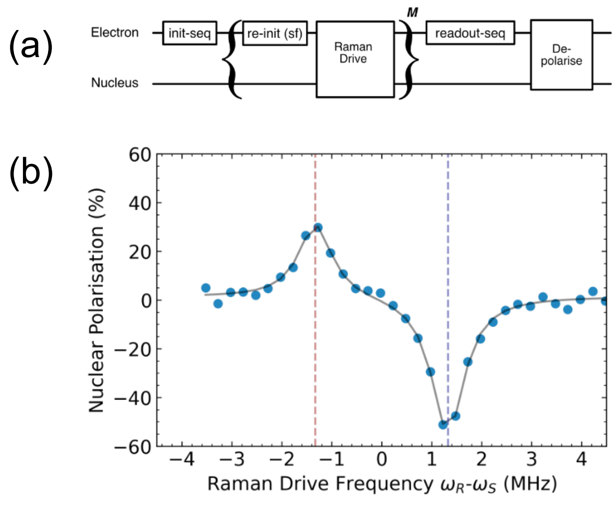

Figure 1: (a) Nuclear spin initialization gates, (b) nuclear polarization as a function of Raman drive frequency