All Optical Initialisation and Readout and Coherent Population Trapping of a Single Germanium Vacancy in Diamond

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Optically active defects in diamond have received considerable interest as platforms for quantum information processing. Yet defects that offer the necessary photonic and spin properties have remained elusive. Here, we investigate the recently discovered and negatively charged germanium vacancy which has attracted recent interest for its attractive spectral properties: its highly stable optical transitions, high Debye-Waller factor and short excited state lifetime. Here, we demonstrate the capability to address the spin sub-levels of the germanium vacancy and thus, perform all optical spin initialisation and readout. We measure an initialisation fidelity of ~ 0.80, and an initialisation rate of ~ 1.5 MHz. Additionally, we generate dark coherent superpositions of the germanium vacancy spin states through coherent population trapping. Future work will utilize the access provided by coherent population trapping to coherently manipulate the spin which will allow for all-optical control of the germanium vacancy.

[1] C. Bradac, et. al., *Nat. Comms.* **10**, 5625 (2019).